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BIG 112 PAGE ISSUE

SILICON CHIP

JULY 2004
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For individuals young and old, the remote control clownfish will keep you entertained for hours! Great for the fish tank or bathtub, simply manoeuvre the fish using with remote control.

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Cat. GT-3225
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Cat. GH-1037
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PUBLISHER'S LETTER

Standby power is a large hidden cost

Our articles on the Energy Meter in this month's issue and the review of the "Power-Mate" energy monitor in last month's issue have highlighted the problem of standby power. On any assessment, standby power is wasted power. It is continuously consumed by appliances merely so that they will be ready to do their intended task, at any time, as soon as we press a button or whatever.

Most people are probably aware that their TV, VCR and microwave ovens all draw standby power of about 5W each and they think, "Oh, well that's only 15W and I can live with that." But standby power in the average household is far more pervasive and if you go from room to room you will probably be surprised to find how much gear you've got which is always pulling power.

In the kitchen, as well as the microwave oven, there is probably the dishwasher, oven (clock), refrigerator, portable vacuum cleaner charger, cordless phone base station and a small audio system and perhaps a TV.

In your home office, you probably have a computer with an ATX power supply, a mobile phone charger, another small audio system, maybe a fax machine and perhaps a few plugpacks to power computer peripherals which are permanently plugged in.

In the family living room there is usually a plethora of electronic gear (TV, VCR, DVD, CD, home theatre system, etc), all with remote controls and all as a result, usually permanently powered up. There may also be an air-conditioner (with remote control) or perhaps you have under-floor heating (again, with stand-by power being drawn). Elsewhere in the home, you may have a door-bell, burglar alarm, perhaps an electric clock and some PIR-controlled lights.

In the bedrooms, the story will be repeated, especially if you have teenage children: TV, audio system, games box, mobile phone charger and so on. In your garage, you may have one or two door openers (both with remote controls) and you may have the odd power tool charger plugged in as well.

Possibly, you can add a few more to this list in your household. Tot them all up and you could easily find that you have a permanent standby power draw of 150 watts or more. Over a year, that could cost you well over $200, depending on the state in which you live. For people who are well off, that's not a big burden. And if you have cold winters, you might argue that it's giving you heating that you would otherwise pay for. But for people on low incomes, standby power is a real issue.

What to do? It's pretty easy really. Just make a habit of turning off or unplugging all appliances which are not being used. Not only will you save power but you may prevent damage to appliances which could happen if you have a power surge or a nearby lightning strike.

And next time you are about to purchase an appliance, consider the standby power it draws. You could save quite a lot of money over the life of the appliance, perhaps even more than the initial purchase price.

Leo Simpson

More great bits 'n pieces from MicroGram

HOT PRICE

USB Net Phone
Make free voice calls when connected to the internet.
Cat. 10129-7 $89

NEW!

USB TV Tuner
Watch TV on your PC or laptop
Watch fullscreen TV on your PC or laptop with this USB 2.0 TV box. Comes with software and a RCA input to capture from VHS, Video cameras etc.
Cat. 3527-7 $199

NEW!

SATA Controller
Add two SATA hard drives to your PC with this handy PCI card.
Cat. 2872-7 $99

12v Mini PC
Perfect for the car or boat. This mini PC is 12v and has enough power to run Windows XP.
Cat. 1150-7 $729

Portable Barcode Scanner
An affordable scanner with great performance. Can be loaded with optional stock-take software.
Cat. 9188-7 $1599

SMS I/O Controller
This I/O controller operates a relay on receipt of an SMS message or sends an SMS with a change of input and can be used with any SIM card.
Cat. 17087-7 $1029

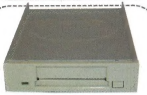
Windows Based Terminal
A standard windows based terminal, suitable for use with all windows servers. Comes with IE 5.5
Cat. 1235-7 $739

USB Smart Card Reader/Writer
PC/SC version 1.0 compliant & the package includes API Library, Demo Program & Demo Source code.
Cat. 8981-7 $139

HOT PRICE

Wireless LAN USB Dongle
This USB dongle adds wireless LAN capability to desktops or laptops.
Cat. 11438-7 $69

VGA Splitter
A powered VGA splitter that can run the second monitor up to 80m from the PC.
Cat. 3445-7 $199

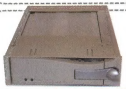


PCMCIA IDE Adapter
Easily read your old full size ATA flash memory with this front access IDE adapter. Hot swap compatible.
Cat. 6668-7 $99

NEW!

Digital TV Tuner
Receives Digital TV on your computer. As transmitted by the FTA stations eg Channels 7, 9, 10, ABC and SBS.
Cat. 3522-7 $279

8 in 1 Memory Card Reader
Will read and write xD, CF I/II, SM, MMC, SD, MS, MS Pro and IBM MicroDrive memory cards via USB 2.0/1.1
Cat. 6786-7 $79



Removable IDE HDD Kit
The tray and frame are both made of aluminium with a plastic front panel. There is a power LED as well as an HDD activity LED. It also has a ball bearing fan.
Cat. 6802-7 $79

DVI KVM Switch
A two way KVM switch for use with a DVI monitor and PS/2 mouse/keyboard.
Cat. 11663-7 $169

Gigabit PCI Adapter
Add a high speed gigabit port to your PC with this inexpensive 1000/100/10Mbps NIC.
Cat. 11359-7 $41

HOT PRICE

USB to PS/2 Converter
Add two PS/2 ports (keyboard & mouse) to your laptop.
Cat. 15121-7 $49

HOT PRICE

Optical (toslink) Switch
This optical switch box has three inputs and one output. The switch has toslink style connections.
Cat. 23000-7 $54

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MAILBAG

Power cords should have listening tests

I must ask on what basis you dismiss the possible usefulness of after-market power cords for hifi, in the Publisher's Letter for the May 2004 issue. If you accept the scientific paradigm that testing a hypothesis is the only way to disprove it, then please tell me about your listening tests of these cables. If your objection is theoretical only, then say so.

Please note that I am not defending their amazing prices, only requesting a scientific approach that would seem to demand that disproving a claim about better sound would require assessment of the sound (not merely of resistance, capacitance, inductance etc).

David Collins,
via email.

Comment: these power cords are only about two metres in length and connect between your power point on the wall and your amplifier (or whatever). So no matter how wondrous the power cord is, the power still has to come via your existing mains wiring, the power point (GPO wall socket) and the internal mains wiring in your amplifier. So the whole exercise is utterly pointless.

If normal supplied power cords were notably poor in construction, with very high wire resistance, poorly made contacts and terminations, etc, a superior cord might have some effect. But standard power cords supplied with brand-name equipment are always quite adequate, in our experience.

Secondly, even if the entire mains power distribution to your amplifier could somehow be improved, eg, cleaner waveform, absolute line voltage regulation. etc, it would still make no difference to the sound quality of your amplifier or any other part of your system. This is because amplifiers are designed to largely reject or be impervious to any disturbances in the power supply rails.

If the power cord incorporated comprehensive filtering to remove all mains hash, switching tones, etc, it might be worthwhile, although typically, mains-radiated hash, switching clicks and control tones do not come into an amplifier via the power supply but are picked up by the input leads or speaker leads. In any case, these exotic power cords make no such claims. In fact, any claims they make are extremely vague and not quantifiable.

All of which IS theory, backed up by lots of practical experience. If anyone believes that there is some slight chance that a hugely expensive short power cord with an exotic name can give an audible improvement, then they are severely deluded.

ESR meter works well

Well done SILICON CHIP for the ESR Meter Mk2 described in the March and April editions this year. The unit basically paid for itself soon after I finished constructing the kit. The first day I used the thing, it made easy work of troubleshooting three different switchmode power supplies that were destined for the junk heap.

It's child's play to operate and the Dick Smith Electronics kit produces a professional looking piece of test equipment.

Jason Cox,
Brisbane, Qld.

Microwave heating separates core halves

I was interested in your article on a "Dirt Cheap, High Current Power Supply" in the October 2003 issue. I had previously been interested in an article on the same subject in the November 1998 issue of Radio and Communications magazine. Both articles detail how to convert a PC power supply to a 13.8V high current supply.

Both articles mention rewinding the main transformer in the supply. Your article details how to separate the two halves of the ferrite core by immersing the transformer in paint stripper. I followed the instructions but the transformer ferrite sections were glued together with some agent that was resistant to paint stripper.

I had tried on a number of occasions over a couple of years to separate the two halves by various means and been frustrated in every case by fracturing the ferrite core. Finally I decided that maybe heating the core in a microwave oven might solve the problem. I placed the transformer in the oven, along with a cup of water to absorb some of the energy – just in case funny things happened. I decided on a period of 60 seconds at full power in a 900 watt microwave oven.

It worked like magic – the core of the transformer was very hot and the two halves came apart easily. The downside of this success was a nasty smell in the oven. I haven't tried again but I suspect I could reduce the "cook" time and thereby reduce the odour and still have the result I needed.

So, if you want to dismantle a switchmode power supply transformer easily, you can use the microwave oven. But don't do it before cooking a meal and make sure you don't burn your fingers on the hot ferrite!

Keith Farmer,
via email.

Complete listing of Autotrax commands

Since I haven't used a CAD package for designing PC boards before I thought I would follow through the 3-part tutorial series by Peter Smith published in the February to April 2004 issues.

While these articles did give a good deal of information I felt they fell short of giving sufficient detail for beginners. Many of the command sequences required to perform a particular function were shortened so much that they could not be followed and the desired function was unable to be performed

without more searching and reading via the web.

One thing that was missing was a complete listing of all the commands available in Autotrax 1.61, which I could not locate in any of the references given. The closest command listing available applied to Easytrax 2.06 which, being an earlier incarnation, is not the same. I finally located an excellent reference specific to Autotrax 1.61 at **http://www.lupinesystems.com/easytrax/**

In fact, the home page at **http://www.lupinesystems.com/** is an excellent site for anyone wanting to start off making PC boards.

Despite my criticism of the lack of detail in these articles, and I do understand that a proper treatment would take up far more space than could be given, I applaud SILICON CHIP for running them. They encouraged me to do something I had intended to do for many years.

Ross Herbert,
Carine, WA.

Comment: thanks for your comments. You've answered your own criticism though – we could not justify all the space that would be required to do what you request.

Slur on real estate agents unjustified

As a person who works in the real estate industry I was deeply offended by your Publisher's Letter in the May 2004 issue. To label all real estate agents as dishonest people is ridiculous. We are a highly regulated industry that is regularly audited; there are very few shysters/hucksters to be found in my industry.

I wish I could say the same for the so-called tradesmen we deal with on a daily basis, including members of trades that would regularly read this magazine.

Ian Boyd-Jones,
Thirroul, NSW.

Comment: Talk about unintended consequences! We apologise.

Jug elements as dummy loads

I think the use of jug elements in the article "Amplifier Testing Without High-Cost Gear" is absolutely brilliant. I'd never thought of that before.

Heating elements from ovens can also be used, as long as the element(s) are matched to the load impedance of the equipment, and that the elements are guarded to prevent accidental contact. Jug and oven elements can also be used for testing high-powered RF amplifiers.

Bryce Cherry,
via email.

Comment: glad you liked the concept but we would not use unshielded jug elements for testing high-powered RF amplifiers. They would radiate a lot of signal.

Surface-mount ICs are agony

I am puzzled that the designer of the Component Video to RGB Converter would put kit builders through the agony of working with surface-mount ICs if the required performance could be achieved easily with normal components.

He says proudly that the MAX4451 "has a -3dB bandwidth of 210MHz . . ." etc but why do you need this for signal with a maximum bandwidth of 5MHz and an adding circuit with unity gain? Surely there are stacks of conventional ICs which would do this job quite adequately?

John Neate,
via email.

Comment: it is true that off-air video signals only have a modest bandwidth (5MHz) but if you want the best picture from DVDs, digital STBs, etc, 100MHz or better is desirable since it gives zero phase shift over the pass-band.

Video projects not user-friendly

SILICON CHIP's range of video projects are innovative, compact, no mains wiring for safety, no connecting cables/wiring needed internally (usually) and easy to construct. But user-friendly? No!

In an effort to keep costs down, safety high and better repeatability, has SILICON CHIP and particularly Jim Rowe, lost sight of the fact that they are messy to use (because of the need to hide them, due to cables connected to front and rear).

As for the Component Video to RGB converter (May 2004), it performs faultlessly. However, it has to be kept

Atmel's AVR, from JED in Australia

JED has designed a range of single board computers and modules as a way of using the AVR without SMT board design

The **AVR570** module (above) is a way of using an ATmega128 CPU on a user base board without having to lay out the intricate, surface-mounted surrounds of the CPU, and then having to manufacture your board on an SMT robot line. Instead you simply layout a square for four 0.1" spaced socket strips and plug in our pre-tested module. The module has the crystal, resetter, AVR-ISP programming header (and an optional JTAG ICE pad), as well as programming signal switching. For a little extra, we load a DS1305 RTC, crystal and Li battery underneath, which uses SPI and port G.
See JED's www site for a datasheet.

AVR573 Single Board Computer

This board uses the AVR570 module and adds 20 An./Dig. inputs, 12 FET outs, LCD/Kbd, 2xRS232, 1xRS485, 1-Wire, power reg. etc. **See www.jedmicro.com.au/avr.htm**

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.

Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

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out of sight like many other recent video projects and then you have to hide a big plugpack (which takes up two power board spaces) behind your entertainment unit, along with other plugpacks which are live at all times. There is often no provision for an On/Off switch on the unit itself either.

How many readers like the idea of a number of hidden plugpacks which are on all the time, hiding behind furniture and plugged into a couple of power distribution boards sitting (probably) on carpet.

The PC board may be small due to the use of modern components but a bigger case with an on/off switch, internal power supply and ALL sockets at the rear, could sit unobtrusively on top of the DVD player or other item. In many cases the front panel would only need an on/off switch and a LED. That's what I intend to do with the Component to RGB Converter.

Alex Kethel,
via email.

Comment: we don't like the idea of multiple (hidden) plugpacks either but we tend to adopt them because they are: (1) cheap and safe (they meet Australian safety and EMC standards); (2) enable a much smaller and cheaper case; (3) remove hum fields from the immediate circuit (can be critical for video and audio devices); and (4) can be built by school students (under school supervision) because there are no mains voltages.

Hot glue not good as high-voltage insulation

On page 86 of the May 2004 issue, a reader asks about substituting hot-glue for silicone sealant to insulate metal nuts on a mains-carrying PC board. I am not familiar with the original circuit but I assume that a degree of insulation was deemed necessary for safety purposes. If so, then hot-glue may prove totally unsuitable.

I am a professional electrical engineer and have been involved in one capacity or another with electronics for about 40 years. It has been my experience that hot-glue (what I would refer to as "hot melt" glue) loses its adhesive properties after about a year - maybe a few years at best. After this, if it is mechanically retained by the way that the glue has set relative to mechanical fixtures then it will "loosen its grip" but stay in position.

However, if it is not mechanically restrained, it will drop off. When the glue is the critical means of mechanical retention it invariably fails. I have seen many devices, where hot-melt glue was used to anchor wiring or components, in which the "anchored" object is now floating free. Sometimes this leads to equipment failure and sometimes just to interesting noises when the equipment is moved.

If this insulation is necessary for safety purposes at any time after construction, then hot melt glue should not be used. Silicone sealant does not act in this manner. It retains tenacious adhesive properties over its lifetime (which can be in excess of 20 years).

Russell McMahon,
via email.

On fraudulent power cords

I've just read your May 2004 editorial on high-priced power cords and thoroughly enjoyed your comments. As the Good Book says (Ecclesiastes) "...there is nothing new under the sun" and this kind of garbage has gone on in the audio world for ages.

I'd be giving away my vintage if I was to relate the waffle that hifi salesmen used when expressing "power". That an amplifier could consume, say 120 watts and blast your ears with 500 "watts" per channel – well, why spoil a good spiel with the facts?

Anyway, I'm off to rewind my power transformers in an anti-clockwise direction, to compensate for the Earth's magnetic field and spin in the southern hemisphere.

Frederick Finkelstein,
via email.

Brass screws give low distortion

Further to your "spot on" Publisher's Letter in the May 2004 issue, my attention has just been drawn to the latest Jaycar Engineering Catalog. On page 14, we read about their Studio 350 kit: "Our kit includes the special 5/32-inch non-plated brass screws that guarantee the lowest possible distortion. Beware of cheap plated steel screws in inferior kits!".

Is it really that easy to improve the sound?

Neville Cohen,
Randwick, NSW.

Comment: in this case, it really is that easy. We specified brass rather than nickel-plated screws for the Studio 350 and Ultra-LD amplifiers because there is a distinct distortion reduction. This is noted on page 25 of the February 2004 article and covered in more detail in the December 2001 article on the ULtra-LD amplifier (see page 63). Dissimilar metal joints in the power signal path can cause distortion.

Smart flash trigger responds to infrared

The article for the Smart Slave Flash Trigger in the July 2003 issue states: "Actually these both have an inbuilt IR (infrared) filter but they still have more than adequate response to visible light to do the job here". This description is wrong.

The BP104 has an IR filter but the filter is there to stop visible light and let the IR light through to the sensor. The specifications sheet for the device shows the spectral response of the device peaks at 950nm.

The IR sensor in this project IS detecting the IR output of the flash gun (not the visible light). And that is good because electronic flash tubes put out more IR (heat) than visible light. Put your hand in front of a flash gun and feel the heat pulse when it is fired.

Dirk Stoffels,
Canberra, ACT.

Comment: you are right. It turns out that the spectrum output of a typical flash tube also peaks in the infrared. Either way, it does not matter whether the detector responds to visible or infrared light – it works!

Component video to RGB converter

Has someone made a boo-boo with regard to the Component Video Converter? Shouldn't the name be "composite video converter"?

I guess that you will blame the autocorrection feature in somebody's spell-

ing checker. Over the years, I have seen some real mess-ups where a minor spelling error has caused the spelling checker to substitute a different word which completely changes the meaning of a sentence.

Harry Pfeifer,
Warragul South, Vic.

Comment: "Component Video" is correct. In this case, the Luminance signal is equivalent to composite video (ie, B&W video). On the other hand, our reference to the project on the front cover as a "Video Standards Converter" was not correct.

Technicians need better communication skills

I almost agree with your comments in the Publisher's Letter in the April 2004 issue, about the status technical people hold with the general public. It is not too good, as you say, and quite undermining for self-esteem.

However, putting some more "Tickets on ourselves" as you express, I think won't help. That will only make our appearance more nerdy. We must overcome a shortcoming within ourselves, as technical people, of not being too good at communicating.

Isn't our world becoming more "touchy feely" and we, by becoming the techos, have gone the other way and shied away from all that. We find more satisfaction in the lab or the back room, away from view.

Joe Public seeks primary advice all too often from the shop counter person, who might have no more technical qualification than some company indoctrination. The real knowledge is elsewhere.

We are in competition with the rest of society for our place. It must be earned. Knowing what we know is great for us but won't raise our status. So our training must include people skills, just as much as basic electronic principles, etc.

Hugh Paton,
Tallangatta, Vic.

More details on ultra-bright LEDs

It was good to see the article in the April 2004 issue about the new breed of ultra-bright LEDs. There certainly are some interesting devices available now. However, just thought I might add some information on a couple of things mentioned in the article.

Lumens per watt figures are a good way to compare LEDs to other light sources, and while most LEDs do come in around 35 lumens per watt or less, some actually perform quite a bit better. Many LED manufacturers bin their LEDs according to colour, voltage drop and light output and some of the top bins can exceed 50 lumens per watt; the red-orange 1W Luxeons are in this class. The Luxeon 5W white devices, although they have a very short life, are also binned, with the top-level bins coming close to 50 lumens per watt.

I have a converted Maglite torch that has a 5W Luxeon LED from one of the better bins, and its output really is impressive compared to an equivalent halogen. It would be close to a 20W halogen in total light output, although admittedly, with fresh batteries (three CR2032 3V lithiums) it pulls around 8 watts from the cells! It is by far the brightest torch I have ever owned.

In regards to halogen replacements that use LEDs, we have evaluated quite a few of these, and none really come close to a 50W halogen, as you would expect - the light output of the best LED halogen replacement bulbs is usually less than 100 lumens, compared to 1000 or more for a 50W halogen. The halogen fittings themselves limit the amount of power a LED-based bulb can use. The maximum seems to be 4W or less – any more than that and you simply cannot remove the heat generated fast enough and the LEDs overheat, reducing their light output and their life-span considerably.

As far as future improvements are concerned, according to a recent US Dept of Energy study, if $100 million was spent on LED development in the next 15 years or so, we should expect to see LEDs in the 180 lumen per watt class, with prices falling to around US$2.50 per kilolumen. This would be a stunning improvement, and even a figure half this good would spell the end of just about every other form of lighting in general use. Some more information on this and LEDs in general is available in our latest issue of *ReNew* magazine.

Lastly, you didn't mention multi-chip LEDs, such as those available from **www.ledsales.com.au** and other suppliers like Roithner Laser, who have multi-chip, ceramic-based arrays up to 20W and 500 or so lumens! These devices generally use standard chips (20 or 25mA-rated) connected in parallel or series-parallel arrays to provide more light than a standard LED. In fact, the Luxeon 5W devices are actually four 1.2W chips connected in a series-parallel configuration.

Lance Turner,
ReNew magazine.

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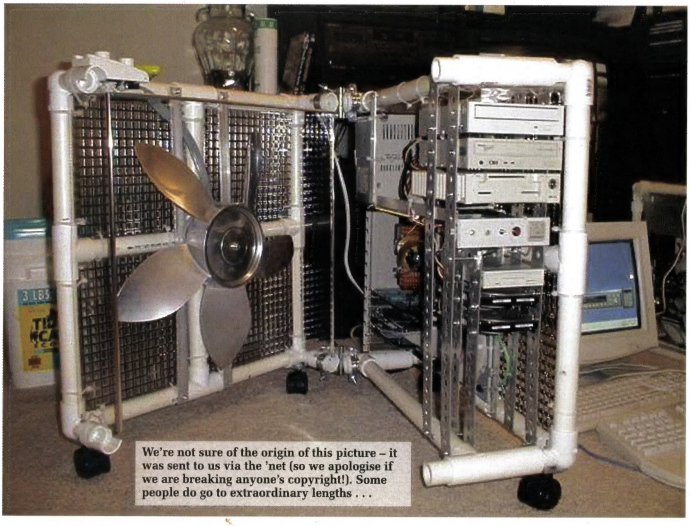
Do you work in a quiet office with a noisy computer? Disconcerting, isn't it?
If you enjoy peace and quiet, there is a solution. And it might not cost you as much as you think!

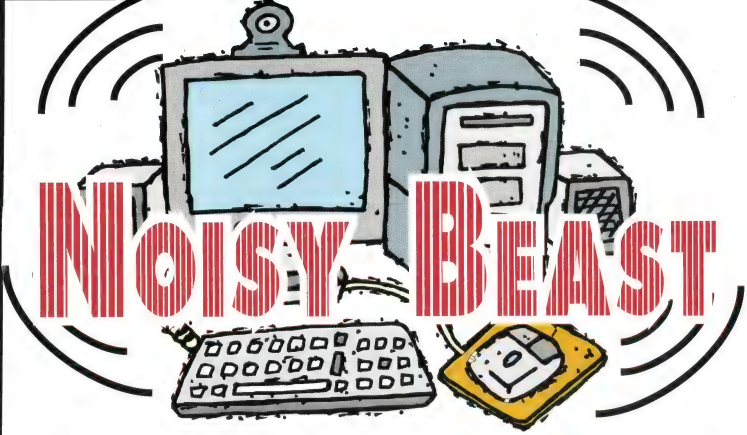
SILENCING A

Or . . . The SILENCE OF THE FANS . . .

By Ross Tester



We're not sure of the origin of this picture – it was sent to us via the 'net (so we apologise if we are breaking anyone's copyright!). Some people do go to extraordinary lengths . . .



This all started a few months ago when he-who-writes-the-cheques finally conceded that my poor old PC wasn't really up to handling today's software. So we purchased a new computer – at the time, the fastest and best-performing system we could find.

Performance-wise, it was superb (once a couple of annoying bugs were ironed out). But it was noisy. Boy it was noisy: anyone walking into my office could instantly hear the noise of the computer above the sparkling repartee.

Back to the supplier

First thing I did was to return the computer to the supplier. Along with the request for the bug fix (it tended to lock up when transferring data via the USB port), I asked them to check out the noise.

A couple of days later the machine was returned. They reckoned they'd fixed the lock-up problem but the noise was exactly the same. Not happy, Jan!

I queried the noise and their service manager told me that the noise level was "absolutely normal" for a fast Pentium IV machine.

Sceptical me didn't really believe him but on investigating further, I found that noisy PCs really were a widespread problem. From the many comments I found on the web and various newsgroups, it would appear that a lot of people are concerned about PC noise. And most put the blame squarely with the CPU manufacturers. They bust their buns to produce faster and faster CPUs (which of course run hotter and hotter), then go and let the side down with just-good-enough fast-revving fans which scream their heads off, relying on after-market suppliers to solve the problem for them.

It's just your average, fast, Pentium IV computer but it's so noisy. Well, it was noisy before a few mods!

We've since heard many different stories about noisy fans. Every supplier, it seems, has a different version. Then the techs put a different slant on it. One that does keep popping up is that Intel had a bad (ie, noisy) batch of fans towards the end of last year. Is that true? No-one is admitting anything, of course.

But here's the rub: we asked one of the companies featured in this article to lend us a Pentium 4 CPU for photography. It was brand new and came with an Intel fan, nearly identical to mine. Just on a whim, we measured the sound output: a full 7dBA less, just sitting on the bench! That's not far off *sounding* half as loud. Mmmm. Makes one wonder, what?

Where to go from here?

And then along came CeBIT. As I mentioned in the brief show report in June SILICON CHIP , there were at least three stands at the show specialising in cooling and silencing PCs (actually the two problems go hand-in-hand).

I talked to the people there and told them that SILICON CHIP was interested in doing a feature article on the subject. All wanted to co-operate with us. And this article is the outcome of those discussions.

I told the companies that we wanted to do two things with this article. First, we wanted to show readers how to go about quietening an existing noisy PC (and did I have the perfect "model"!).

Second, we wanted to "start from scratch" – how to go about building the quietest PC we could manage. Note that I said "we could manage" – there is a dramatically quieter option available if you have deep pockets (see separate panel). But this approach would not be all that practical for the average person, so we've taken a more realistic, lower dollar approach.

LowNoisePC

The first person I talked to was Rodney Maslovsky of LowNoisePC (www.lownoisepc.com; (02) 9403 3305). Guess what he specialises in?

Rodney discussed the various options possible for making my noisy PC quieter – a lot quieter. It is mainly with his advice, and gear, that I attacked my PC. And as you'll see, "attacked" is quite literally true – with a power drill and nibbler to start with! The step-by-step approach using a lot of LowNoisePC gear follows shortly.

Altech Computers

I had already seen Altech Computers (www.altech.com.au; (02) 9735 5655) at CeBIT but it was actually Rodney Maslovsky who suggested I also talk to Altech (and they are a competitor of his!) about cases. His philosophy was that if you want a quiet PC, the place to start is the case.

Most PC suppliers put together systems based on a variety of sources: a case from here, (usually including a power supply), motherboard from there, CPU, memory, etc from somewhere else, along with disk drives, etc etc. And due to the extremely competitive nature of the computer game, a dollar or so saved here and there can really make a difference.

Incidentally, that's one of the reasons it's hard for the average person to build a PC these days that's as cheap as a ready-built one. As well as their economies of scale (a few dollars here, a few cents there) they shop around to find the best deals on all the bits and pieces.

Most "low cost" ready-built PCs come in cases which retail for as little as $45 or so. And that includes the power supply!

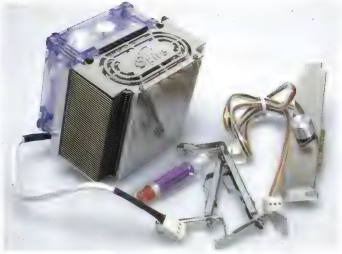
I have to say, by and large cheap cases are noisy cases – their panels are notoriously thin and often ill-fitting, they vibrate, their standard of assembly is not that great (my noisy PC has just 12 rivets holding the whole thing together!). The power supply is noisy, too.

Yet you can pay hundreds, even thousands of dollars for a good PC case. You must be getting something extra for your money – and you are. Build quality, thickness, rigidity, lack of resonances . . . as you go up in price, things generally do improve. Of course, there are exceptions.

Rodney suggested that one of the best "reasonable price" cases around was the Antec Sonata. It's actually marketed as a low-noise case. He'd put his money where his mouth was and built his own PC in one of them. And it was certainly very quiet!

The Australian agents for Antec, by

The Antec "Sonata" is designed as a very low noise case and is a great place to start if you're building a new PC. Along with rigidity and several noise and vibration reducing features, it is supplied with a low-noise supply and low-noise case fan. Note the extra-large airflow holes on the rear panel (above). At left is the latch which opens the side panel to allow access to the "works".



Two of the myriad of choices for a CPU cooler. Above is the giant Zalman Ultra Quiet CNPS700A-AlCu (the one we eventually used) while at right is the Spire WhisperRock IV. Both come with speed controllers, heatsink compound and all the fittings you need. Models are available for AMD/P3, etc CPUs.

the way, are Altech Computers.

Incidentally, you can find a review of the Antec Sonata at www.overclockers.com.au/article.php?id=161513 – along with a huge range of other information. It's a really informative site.

Remember, I said that cooling and silencing go hand-in-hand – and one of the major problems that overclockers face is in getting rid of the extra heat that the overworked CPU generates. Hence the interest on this site.

Apart from the Sonata there are, many other quality cases which are well-made and should be pretty quiet. However, having had a recommendation, we decided to go that route.

CPU Fans

The second part of the equation is the fan(s) you use. There are fans and there are FANS!

First of all, let's look at the most important fan in a PC, the one trying to cool your CPU. You can buy real el-cheapo CPU fans in some stores (and also at flea markets, etc) for as little as $10-$20 (or less!). In a word, don't!

It pays to spend a little more on the fan and get quality. Even the good CPU fans (decent bearings, etc) aren't that expensive – around $45 seems to be about the starting point for a good'un, maybe a bit more for something that's really out of this world.

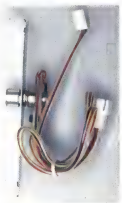
As well as having an airflow rating (at a particular voltage, usually 12V), good fans will also give you a noise level, in dB. The really good fans have very low ratings – they are rated at 30dB or even less (which is way under background level in most offices).

I borrowed a digital sound level meter from Jaycar and measured the noise from the CPU fan in my PC. It was over 70dBA. As one of the fan specialists said, "that's not a fan, that's a siren!"

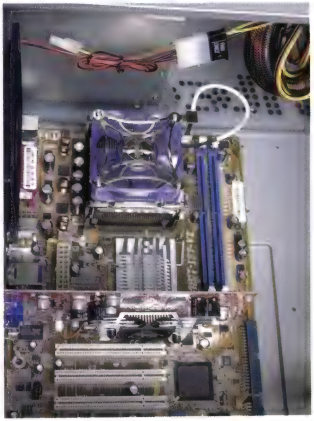
A little basic fan theory: cooling relies on heat transfer (ie, getting the heat from the chip to the heatsink) and airflow. Airflow relies on three things – a clear airflow path, fan size and fan speed. We'll get back to the clear airflow path in a moment.

The larger the fan, the higher the airflow. The faster the fan, the higher the airflow. Unfortunately, the faster the fan, generally the more noise. Therefore, it's better to have a larger fan than a faster fan.

Ideally, you need a fan that's as large as will fit on your CPU in the case you're using. Often the power supply is cheek-by-jowel with the edge of the mainboard and you can't fit a really large fan. Fortunately, there are some



A fan speed controller suitable for the CPU fan or case fan. This one mounts on a spare expansion card backplane; others are available for internal mounting (ie, set-and-forget).



Here's one of the low-noise "Spire" CPU fans fitted to an Abit motherboard, along with a fan-equipped graphics card in an Antec Sonata case. Some of these small fans are noisy but there are cures. This computer also has a low-noise power supply. Note the case fan (just seen at left) is plugged into a power supply socket marked "fan only" – this allows the power supply "smarts" to also control the case fan.

Just one of the many low-noise case fans we looked at, one of the "Spire" models (from LowNoisePC). The line socket on the right goes to a standard (Molex) disk drive power plug, while the little white socket on the left connects to a speed controller. Just as important as having a low-noise fan is having a good airflow path. Many PC cases simply do not have enough air holes (or big enough ones!).

very good, slightly smaller fans.

But airflow is itself only part of the story. The air must be able to extract heat from the CPU heatsink – and the best way it can do this is with large fins on the heatsink to allow more contact with the airflow. Again, size can be a problem in many PC cases.

Let's get back to fan speed. Most PCs run fans in one of two ways – flat out (ie, always connected to 12V), so they're always as noisy as they can be, or in the case of many modern PCs, the fan speed is varied according to the CPU temperature.

It seems like a good idea but if you have a noisy fan, this is where you can get one of the most annoying features – a variably pitched whine.

The best approach is to run the thing from 12V via a variable speed control. These are very cheap and can be either a little stick-on box or fitted to a back-plane plate which sits in one of the unoccupied slots on the back plane.

Run it slower!

For the vast majority of users and uses, the CPU does NOT need to be cooled at its maximum. Provided the system remains stable, you can slow the fan down (remember, that means less noise). It usually doesn't really matter that the CPU is running slightly hotter than it would with maximum airflow. How much is slightly hotter? Excellent question.

Over-clockers run their CPUs hotter (often much hotter) than normal, then try to get rid of the heat the best way they can. If the system starts behaving erratically (eg, locking up or shutting down) it's a fair bet that the CPU is running too hot. In this case, the fan speed must be increased or a better fan fitted.

For most users, you can back the fan speed off a bit for a really worthwhile reduction in noise. It is unlikely (though not impossible) that you'll do any damage by reducing fan speed.

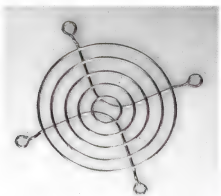
Case fans

A while ago, we made mention of a clear airflow path. This is most relevant when it comes to case fans.

Most cases have provision for a case fan but the majority, especially cheaper cases, don't allow enough airflow. Some have a circular pattern of holes punched into the case with extra holes around the outside for fan mounting. Some have four slots cut instead to suit quick-mount fans. Some cases have both.

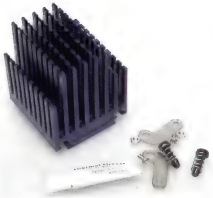
LowNoisePC recommend that the punched airflow holes be removed, opened out to the full diameter of the fan. The punched holes severely restrict the amount of air which can pass through (compare the punched holes to the very open airflow of the power supply fan).

Also note that case fans can be set to suck or blow, depending on which way around they are mounted (not the polarity – most fans do not work with back-to-front polarity). Which way around is correct?



A wire finger-guard allows almost as much airflow as no guard. They're available in sizes to suit all fans. (This one is for an 80mm case fan).

Here are a couple of low-noise power supplies – at left the Zalman "Quiet Solution" 300W supply, while at right is the Vantec "iON"400W supply. We used the Zalman supply in our PC makeover because it was about 2mm smaller than the Vantec. And in our case, size did matter!



Coolers for graphics cards (left) and Northbridge chips (above). The one above is merely a larger heatsink than normal; the one at left is noteworthy because it uses heatpipe technology to shunt heat into the large heatsink, where it will then dissipate.

Another excellent question.

This time, there is no correct answer. It depends whether you are trying to suck or blow – extract warm air from the case, or force cooler outside air into the case.

Power supplies are almost always extractors and for this reason alone, case fans usually need to be blowers, especially if your case doesn't have really good provision for getting air inside the case (lots of air holes and slots).

If the case is really well designed so that air is channelled over the most sensitive components (CPU, GPU, etc) there may be some advantage in making the case fan an extractor.

Power supplies

We have mentioned the power supply (and its fan) a couple of times. After the CPU fan, the power supply fan is often one of the main noise culprits – and it's one you cannot do much about (please don't be tempted to open the supply and fit a quieter fan!).

What you can do is fit a quieter power supply. Like cases, power supplies have a huge price range and it's not all about capacity. If you can buy a whole case *with supply* for between $45 and $70, imagine the corners that have been cut to do it.

Low noise supplies

We've shown two very quiet supplies: a Zalman "Quiet Solution" 300W noiseless power supply and a Vantec "iON" 400W supply, both of which are drop-in replacements for the existing supply in your computer.

The difference in fan noise between these and a standard supply is quite noticeable and the specs back it up: the Zalman, for example, is claimed to operate at <20dB in noiseless mode (up to 40°C), rising to 25dB maximum in its "silent" mode (40-60°C) and <30dB if the power supply temperature sensors hit 60°C. Most standard power supply fans run at more than 30dB-40dB all the time.

Because power supplies are sealed boxes, there is no danger to you in replacing them: it's simply a matter of disconnecting cables, undoing four screws and sliding the old supply out – then sliding the new one in, fastening screws and reconnecting the cables.

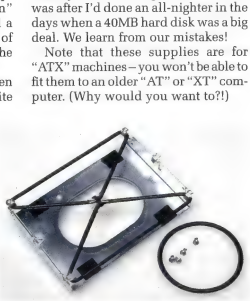
Fortunately virtually all supplies use a standard cut-out and screw positions, so you shouldn't have any problem there.

One little trap for young players: the power connectors for hard disk drives are moulded so that they can only go in one way. Theoretically, I once destroyed a perfectly good hard disk drive by rushing to force the connectors in the wrong way. I remember thinking as I did it "gee, these aren't usually this hard to go in . . ." OK, it was after I'd done an all-nighter in the days when a 40MB hard disk was a big deal. We learn from our mistakes!

Note that these supplies are for "ATX" machines – you won't be able to fit them to an older "AT" or "XT" computer. (Why would you want to?!)

These Antec gasket kits (Altech) are intended to kill noise before it has a chance to resonate on the case. The kit on the left has washers and gaskets for case fan and power supply while the one on the right has fan gaskets only.

(Left): another example of heatpipe cooling, this time for a hard disk drive. Many of today's high speed and high-end drives run particularly hot and several now come with fans or fan mounts. Trouble is, they add to the PC noise. This mount also includes bushes which prevent (or at least minimize) hard disk drive noise and vibration from being transmitted through to the case, where it might cause resonances. The HDD mount at right doesn't offer any cooling but does minimise noise and vibration transmission, securing the drive in special rubber bands.



Here's the Thermaltake "Silent Tower" heatpipe-based CPU cooler. The thick solid copper base transfers the heat from the CPU, with the heat pipes carrying it away to the radiator. This system mounts through the motherboard, requiring the normal CPU cooler bracket to be removed. One of the H-shaped brackets fits under the motherboard, with insulator, while the second slots in above the copper base, pulling it hard down on the CPU. The smaller "H" bracket is for AMD CPUs.

And, as we said before, don't be tempted to open the power supply box itself, though: as the iON manual tells you, ". . . it will cause thunderstroke danger." (!!)

Even these very quiet supplies don't cost sheep stations – the Zalman 300W model retails for around $90; the Vantec iON 400W for about $118.

That's significantly more than a replacement standard supply will cost – but you do want quiet, don't you!

Video cards

The majority of computers sold these days have integrated graphics – the video "card" is part of the motherboard. Even those computers which do have a separate video card do not normally have a fan on the card – usually just a heatsink.

However, high-end video cards, such as would be used by gamers or those doing a lot of video processing work, usually incorporate a fan. Some are very quiet, others (just like CPU fans) scream their little heads off.

You can buy replacement fans for most video cards if this is a problem (some have fans integrated into the card itself). They may only contribute a small proportion of the noise – but any reduction is worthwhile.

Northbridge coolers

The Northbridge chip (found on modern PCs) is the second largest chip after the CPU.

In most cases it will simply have a heatsink, not a fan. But some high-end machines do have a heatsink/fan assembly on the Northbridge. Again, these are likely to be tiny, noisy fans. Once again, you can buy low-noise fans to replace them and lower the overall noise problem.

Hard drives, CD/DVD, etc

High speed, high capacity drives – especially SCSI – can be noisy. There are several methods of reducing drive noise. The simplest of course is to fit a lower-noise drive – but this is not all that practical nor economical.

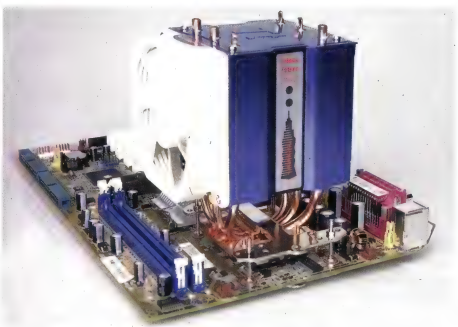
The most popular way is to mount the hard drive (or CD, etc) in a noise-reducing cradle. These avoid or reduce the metal-to-metal contact which can transmit drive noise to the case. The NoiseMagic NoVibes III (from LowNoisePC) is a very economical mount which holds the drive in place by special rubber bands, with the drive itself sitting on rubber pads.

There are other approaches – plastic or nylon pads on which the drives sit, also trying to reduce transmitted noise.

Hard drives operate notoriously hot, especially modern high speed drives and even more especially many fast SCSI drives. And heat is one of the things that will eventually kill them. Most PC cases virtually force you to stack drives one on top of the other; for even more heat build up.

This is often "cured"– by adding a fan. Uh-oh – more noise! There are some exceptions with very quiet drive fans but usually they are tiny little high revving banshees.

A much better approach is to use a "heat pipe" mount such as the Zalman ZM-2HC1 we've shown here (it also came from LowNoisePC but of



The Silent Tower fitted to the CPU/motherboard. Kinda dominates it, doesn't it! We are a little concerned about the mass of the unit hanging off the (vertical) motherboard. And we were disappointed in the amount of fan noise – Thermaltake believe it may have been damaged in transit.

course there are many others). It silently shunts the heat away from the drive without the use of fans. This mount, which includes rubber dampers to minimise drive noise even more, takes a standard 3-1/2in drive and fits to a standard 5-1/4in drive bay.

As a general rule, if you have the room, always mount your drives with as much space between them as possible.

Other things to cool?

If you are trying to extract the last xteenth of performance from your PC, it's likely that you are going to be running everything hot. And of course you have to get rid of that heat before it cooks something.

We've seen one gamer's machine with no less that 12 case fans fitted. That's not overkill, that's OVERKILL! There is a better way. You can get heatsinks or coolers for just about every part of your PC today – even such things as memory sticks. Any of the suppliers mentioned in this article will be able to help you out here.

Ducting

Sometimes ducting is fitted between an external case fan and a hot part of the "works" (usually the CPU). Whether this works for you, especially in an after-market setup, is problematical.

We tried ducting before we did anything else – and found the CPU noise level actually increased significantly!

Heat pipes

We mentioned heat pipes a moment ago for hard drives and graphics cards. But you can also get heat pipe coolers for CPUs.

One of the more interesting stands we saw at CeBIT was that of Anyware Computer Accessories (www.anyware.com.au, 02 9879 5788). The thing that really caught our attention (along with some great looking cases, silent power supplies, CPU fans, etc) was the new Thermaltake "Silent Tower" Heatpipe Cooling system. Anyware are Thermaltake's major distributor.

The heatpipe clamps to the PC motherboard, sandwiching the CPU. A low-speed (2500 rpm, claimed at 21dBA) 80mm fan pushed air through the heatpipe.

It's not small, reaching out to about 150mm above the surface and is about 110 x 95mm. A pair of large H-shaped brackets (and insulating gasket) holding it firmly in place.

If you want it in one handy package, this POLO12 kit from Thermaltake/ Anyware Computers could be it: a low noise 410W power supply, quiet 80mm case fan and CPU fan/heatsink and three fan speed controllers – two mounted on a drive-bay bracket and one on a backplane bracket. It sells for $149.

The standard mounting holes, normally used for traditional CPU coolers, are used. As the vast majority (if not all) motherboards come with a bracket already situated in these mounting holes, this must be removed prior to mounting the tower.

Fitting was quite easy but the instructions do suffer a common oriental failing: tiny, tiny type (bordering on unreadable).

While it works, our major reservation with the heat pipe is the rather massive structure it places on the motherboard. Remember that in a tower case, the motherboard is mounted vertically, meaning the heatpipe assembly is "hanging out in space", horizontal to the motherboard.

While the weight is not overly high, we're worried about what this heatpipe might do in time. Could the stresses deform the board? We don't know – we're only raising the possibility.

The other disturbing aspect to the Thermaltake heatpipe is its fan noise. As we said, Thermaltake claim 21dB (with respect to what?) but we measured this fan at 55dBA. That's significantly higher than any of the other approaches we've tried in this article and not too far off the 66dBA we were suffering from originally.

Admittedly, the Thermaltake heatpipe fan is largely airflow noise, not the highly annoying whine we had. And of course, you can fit a speed controller and reduce that noise somewhat.

Thermaltake were staggered at our reading and believed that the fan may have been damaged in transit.

Despite our reservations, it does look very impressive! Recommended retail price of the Silent Tower is $59.00.

Thermaltake Cooling Kit

There was another product from Thermaltake/Anyware which caught our attention: a purpose-designed cooling "kit" designed to do exactly what we are talking about in this article.

The Polo12 comes in a little carry box, as photographed, and consists of a 410W "Silent Purepower" power supply, claimed to operate with only 17dBA during normal operation; a 120mm adjustable-speed case fan (operating from 1300 to 3000 RPM); an 80 x 80 x 25mm CPU cooler, also with 1300-3000 RPM adjustable speed and a large heatsink with copper base; two manual speed controllers – one is a 2-channel unit designed for the front panel (in a spare 5-1/4in drive bay) while the other is a single-channel unit for the rear panel (in an unused

expansion slot position).

The CPU cooler, by the way, comes with all the hardware you will need for a Pentium 4, AMD K7 or K8 chip.

And the 410W supply is tricked-up with pretty blue LEDs – though these would be somewhat wasted inside any case without a see-through side panel. But we can confirm it is beautifully quiet!

The Thermaltake POLO12 kit is available through Anyware Computer Accessories resellers for $149.

Water cooling

Yeah, we know, water cooling, it's off with the pixies, right? Something that real geeks might do but not for you? You shouldn't mix water and electricity, right? What happens if it springs a leak?

Mmm . . . not exactly: water cooling is becoming more common these days. A lot of it might be to do with how it looks but there is more to water cooling than appearance.

Water cooling IS a viable proposition if (a) your machine operates very hot – perhaps by over-clocking, (b) you don't mind having pipes all around your computer, and (c) you don't mind spending money!

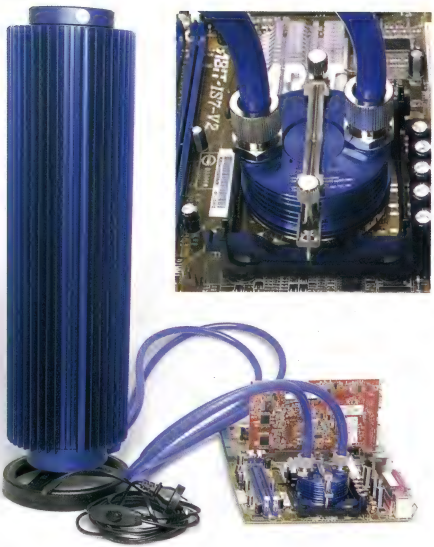
They work just like water cooling in a car engine – a pump forces coolant through the system, which transfers heat into the coolant via heatsinks; then a fan pushes air through a radiator to cool the coolant again.

We showed one watercooled PC in last month's CeBIT report – a 2.4GHz Intel over-clocked to 3.5GHz. Normally this would be a pretty unstable beast but they assured us it was perfectly happy operating at this speed.

Apart from the cost and hardware, one of the biggest problems with water cooling has been noise – both from the water pump and from the fan. These problems have largely been overcome in recent times, with virtually silent pumps and fans now available.

Typical of the modern genre of water cooling is the Zalman "Reserator" – a contraction of reservoir and radiator – along with its matching CPU water block.

This rather imposing looking device (the radiator section stands some 600m high!) has an integral pump which circulates water into the computer, extracting heat from the CPU (and graphics card if the optional block is fitted) and thence back to the radiator.



Whether it's legitimately to get rid of a lot of heat or simply for the "wow" factor, the big Zalman "Reserator" Fanless Water Cooling System sure looks impressive. Shown here is the basic system; you can also cool the graphics card and other heat-sensitive components with add-ons. Inset is the CPU water block. We haven't shown any of the valves on the pipes which control the coolant flow levels.

Does it work? The manufacturers say so – and the photo we showed last month ably demonstrates it. But we weren't quite at the thrillseeker stage enough to fully install the Reserator on one of our systems – just enough to take a few photos. However, even this much convinced us that it wouldn't be too difficult to do it "for real".

One of the drawbacks of water cooling is that you don't know something is wrong (eg, a blockage or pump failure) until it's too late. For this reason, Zalman include a flow indicator which tells you that there is circulation occuring.

The Zalman Reserator kit sells for around $350.00 from Altec Computer resellers.

Contacts:

Of the three organisations mentioned in this article two are distributors, selling through a chain of dealers throughout the country.

LowNoisePC sells direct to the public, mainly via their website (www.lownoisepc.com.au). Contact is Rodney Maslovsky, (02) 9403 3305.

Altech Computers (02 9735 5655 (www.altech.com.au) and Anyware Computers (02 9879 5788 (www.anyware.com.au) will be able to direct you to their resellers.

The ultimate silent PC?

Proudly on display at Altech was their very-new Zalman TNN500A "Totally NoNoise" case. It was so new it wasn't even in the country for CeBIT, only three weeks before. (The best laid plans, etc, etc).

"Totally NoNoise" is not an idle claim – this computer case has all but eliminated noise so it's ideal for use in extremely quiet environments. Into the bargain, it also offers zero dust and zero electromagnetic interference.

Primarily, Zalman have eliminated noise by eliminating fans. The special low-noise power supply is fanless; the CPU is cooled by heat pipes which duct heat away to the case. The high-end graphics card and the hard disk drive mounts also use heat pipes instead of a fan. And the very heavy duty case (5mm aluminium) itself forms a large heatsink

While hard disk drives will normally generate some noise (after all, they are mechanical), the drives are locked away behind sound-quieting doors and special disk mounting arrangements mean any vibration or other noise is not transmitted through to the case. And some brands/types of hard disk drives are much quieter than others to start with (Zalman recommend hydraulic bearing hard drives).

With 1GB flash disks already on the market and 2GB becoming available, some users may be able to get away with no mechanical disk drives.

In the demonstration model at Altech (photographed here), it was fully set up and tricked up with those fancy neon and LED lights. Believe it or not, the ONLY noise you could hear was a tiny buzz from one of the neon tubes. "Have to replace that tube," they said!

Just like in the Mafia, silence does, of course, have a cost. The case alone will set you back around $1300. By the time you've selected all the other low-noise components for this computer (and you'd want a high performance motherboard/CPU/graphics card/etc) you'd be up for the best part of three to four grand.

Is it worth it? For the average user, probably not – unless silence is golden, eg, in a home theatre system. Altech tell us that the Zalman NoNoise case has attracted a lot of attention from TV and Sound Studios, where *any* noise from a computer can be an absolute disaster. (We recently toured one of Australia's leading sound studios and they had gone to the trouble of housing their computers in a soundproof room next door via long cables. With this case, they wouldn't need to.)

It's big (670h x 400d x 286w [mm], including castor wheels) and it's heavy (case alone is 25kg plus motherboard, cards, disk drives, etc).

The Zalman Totally NoNoise case is available exclusively through Altech Computers resellers.

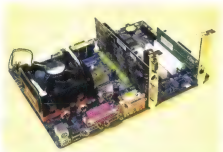
It certainly makes a statement – but it does it oh, so silently.

Silencing my noisy PC – step-by-step.

(1) Disconnect everything external. Mains power lead (first, of course) and everything else which plugs into the back (or front) of your computer: monitor power (not always), monitor signal, printer, speakers, network connections, USB devices, and so on.

Then open up your case – various cases work in various ways. Some are screwless, others have screws to release one side panel; others have six screws which allows the whole top of the case to be removed.

(2) Disconnect everything internal: power supply (1 large Molex plug/socket on an ATX), HDD/CD-ROM and FDD ribbon cables, power leads to all the disk drives, audio cable to the CD-ROM and all the cables which connect to the front panel switches and LEDs. A tip here: draw yourself a mud map of which connectors go where. Most motherboards are labelled these days, as are the connectors – but it's a lot easier if you have drawn a diagram and labelled it with which PC board headers go to which connectors.

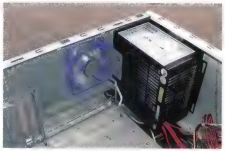


(3) Remove the motherboard. If you're a thrill-seeker, you can skip this step. But I really don't like the idea of swarf shorting out motherboard components . . . and besides, it's a lot easier to work on the motherboard outside the case.

There are normally six screws holding an "ATX" motherboard in place (sometimes eight). That doesn't include the backplane screws which hold expansion cards in place, which you'll also need to remove.

(4) If you're fitting a case fan AND the airflow path is made up of a lot of tiny holes, cut around the outside of the outer circle of holes (we used a drill first, then a nibbler) and smooth the edges with a file. Be sure to give the case a good clean-out to remove any swarf.

(5) Fit the case fan inside the case with a wire finger-guard on the outside of the case. Note how much clearer the airflow path is now – almost the same as the power supply. Four screws normally hold both fan and guard in place. Low-noise fans normally don't need anything extra but standard fans should be used with a noise-reducing gasket.



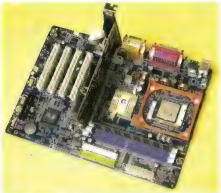
(6) Speaking of the power supply, now's the time to fit the new low-noise one. Before you do, though, check that it is the same size as the one coming out. We found one was about 2mm deeper than the existing one and simply wouldn't fit in the case once the new fan/heatsink was fitted (needless to say, discovered after the event . . .).

Four screws hold the power supply on the rear of the PC. If you are going to fit a gasket, it should be done now.

If you think it would be a good idea about now to test the power supply and case fan for noise, we've got some bad news: ATX supplies need to be connected to the motherboard so that you can "start" them with the power switch. So you're going to have to be patient!

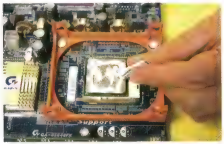
Put the case to one side while we attack the motherboard . . .

Here's how I attacked my perfectly good – but very noisy – PC. Naturally, not all cases, motherboards, fans and heatsinks will be the same. But they tend to follow the same basic principles, so use these photos and descriptions to silence your own particular PC. And am I happy with the results? You better believe it. It's so quiet I could easily doze off. . .

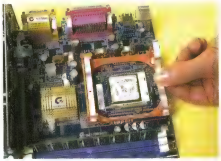


(7) Have a good look at the CPU heatsink/fan assembly to determine how it comes off. Most have some form of spring clips which need to be pushed down and out to release them.

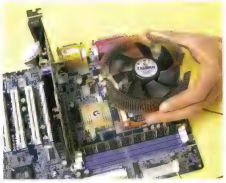
In most circumstances, you don't need to remove the heatsink retaining bracket (the orange thing in our photos) which is fixed to the motherboard. The exception would be things like the Thermaltake heat pipe which fixes through the board.



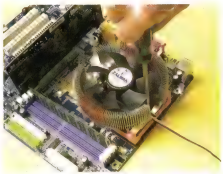
(8) Clean the old heatsink gunk from the top of the CPU chip with a piece of tissue paper. It's probably hardened a bit by now and invariably, new CPU fan/heatsink assemblies come with new heatsink compound. Put some new heatsink compound on the top of the CPU.



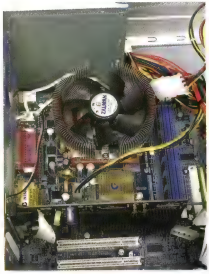
(9) Follow the instructions with your fan/heatsink assembly to mount it to the bracket, in intimate contact with the CPU. Our Zalman CNP7000A, for instance, simply had two aluminium pieces (called "retention guides") which fitted through the bracket and two screws secured the fan/heatsink.



(10) Ensure that the CPU and heatsink are in intimate contact and that the heatsink is level (ie, not mounted at an angle). Some heatsinks will do this automatically as they are fastened in place but others – such as the Silent Tower heatpipe – are fastened down by four nuts which keep their brackets under pressure. These must be tightened evenly.



(11) If you're fitting one of the backplane fan speed controls, remove one of the back-plane covers and screw the speed control in its place. Alternatively, internal speed controllers can now be fitted. Connect the fan power socket to the controller and the controller power socket to the CPU fan outlet on the motherboard.



(12) Now reconnect everything you disconnected before. Aren't you glad you made a mud map? Check twice to make sure all the drives, the front panel switches/LEDs, CD sound, etc are all connected as they should be.

If you are mounting a heatsink which needs to pass through the board (such as the Thermaltake Silent Tower), you need to remove the heatsink mounting bracket from the motherboard. In this case, prise up the four pegs on the top side of the board and remove them, then carefully push the bracket pins through from the underside. Don't slip – motherboard tracks are very fine and easily damaged!

The above photo shows the cooling fan and its mounting bracket, as removed from the motherboard.

Now you're ready for the "smoke test" – and hopefully everything will be OK. Set the fan speeds to the noise level required and monitor CPU temperatures.

Starting from scratch – *building* a low-noise PC

If you want a ***new*** low-noise PC, the approach isn't too different . . . except that you aren't starting behind the 8-ball with a noisy case. All the products and techniques about quieting a PC earlier in this article are also applicable to building a quiet PC from scratch.

The important thing, as we discussed, is to start with a quality case.

We mentioned before the Antec Sonata low-noise case from Altech. While there are many other cases around, some of which probably offer low noise, this case impressed us because it's designed and made to be low noise. Let's see why:

Overall construction: the first impression you get is that the Sonata is heavy and solid. First impressions are correct. It is beautifully made – I'm not real sure yet about the "piano black" finish (dust and fingerprints really show up on high gloss) but time will tell.

I mentioned previously that my el-cheapo case was held together with 12 rivets. I lost count at about 20 on the Sonata, and that was because I didn't want to completely disassemble the thing.

120mm case fan: not only is it big and can therefore rev slower, the cut-out is not a series of tiny punched holes. The airflow is very good – almost as good as the power supply fan. Just as important (perhaps even more so), the fan is mounted to the case on bushes so there is no (or minimal) noise transfer to the case.

The case has provision for mounting a second 120mm fan alongside the drive bays – and the plastic mounting bushes are included in the bag of hardware.

Low-noise power supply: the PSU fitted to the Sonata is the Antec Trupower 380W. It's not the top-of-the-line low-noise supply but it's not far from it. We've already mentioned the power supply fan airflow; the power supply really is whisper quiet.

Incidentally, the power supply has special "fan only" power sockets which allow the case fan to come under the power supply's noise reduction system.

One really neat point about the Trupower: it has a four-pin (12V, 5V) "Molex" power socket (hard disk type) on the back of the supply, next to the power switch. Great if you want to power something externally (like an external drive, etc).

Special HDD mounting: just about every computer we've seen has the drive bays accessible from the front of the case, with the drives mounting fore and aft. Not so the Sonata: the HDD drive bays can only be accessed from inside the case, with the drives mounting side-to-side in drive caddies (we haven't seen that used since 8086 machines!) located low down behind the front panel. And all of the drives mount on the caddies on rubber grommets with special screws so once again there is no metal-to-metal contact; minimal vibration/noise transfer so no resonances.

Easy access: two large thumb-screws fasten the side panel to the rear panel. Once these are removed, the side panel can be unlocked (yes, with a key) and the latch sprung to allow the side panel to swing open. Once fully opened, it can be removed if you wish to work on the machine.

Similarly, all externally-accessed drives (CD/DVD/floppy) are accessed by unlocking and opening a door on the front panel. This might seem like overkill but the front panel door effectively masks the noise of what are often noisy devices. By the way, all externally-accessed drives mount in the conventional way in bays.

What's the damage?

You can expect to pay around $200 for the Antech Sonata. Yes, it's a lot more than the "standard" cases most PCs come in. But it's a lot more case – worth every cent of it! **SC**

Another look at some of the special features of the quiet Antec Sonata case: left is the front with the externally-accessible drive bay door open (and one face plate removed!) Closing this door cuts down on significant amount of noise (from CD-ROM drives, for example). As mentioned in the text, all "internal" hard disk drives mount on special carriers to minimise noise and vibration transfer – one such carrier is shown above right, complete with hard disk drive fitted on bushes.

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By PETER SMITH

MICROPOWER BATTERY PROTECTOR

BACK IN MAY 2002, we presented the "Battery Guardian", a project designed specifically for protecting 12V car batteries from over-discharge. This unit has proven to be very popular and is still available from kit suppliers.

This new design does not supersede the Battery Guardian – at least not when it comes to 12V car batteries. Instead, it's a more flexible alternative that can be used with a wide range of battery voltages.

In this new "Micropower Battery Protector", we've dispensed with the low-battery warning circuitry and the relatively cheap N-channel MOSFET used in the Battery Guardian in favour of a physically smaller module that steals much less battery power. It costs a little more but can switch lower voltages, allowing it to be used with 6V & 12V lead-acid batteries and 4-cell to 10-cell NiCd and NiMH battery packs.

Most battery-powered equipment provides no mechanism for disconnecting the batteries when they're exhausted. Even when the voltage drops too low for normal operation, battery drain usually continues until all available energy is expended. This is particularly true of equipment designed to be powered from alkaline or carbon cells but retro-fitted with rechargeables.

Another example is emergency lighting and security equipment designed to be float-charged from the mains. In an extended blackout period, the batteries can be completely drained and may not recover when the mains power is finally restored.

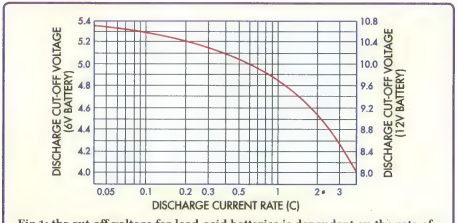

Fig.1: the cut-off voltage for lead-acid batteries is dependent on the rate of discharge. This graph enables you to determine the correct voltage for your application. Although representative of "Panasonic" brand 1.3Ah - 33Ah VRLA batteries, all good quality sealed lead-acid batteries will exhibit similar characteristics.

Death by discharge

Over-discharge is undoubtedly one of the main causes of early battery failure. How well a particular battery can cope varies according to type and application. Some "gel" electrolyte lead-acid batteries will not fully recover after a discharge right down to 0V. On the other hand, batteries designed for deep-cycle use can usually withstand such treatment, albeit with a reduction in maximum cycle life.

The latest generation of NiCd and NiMH cells can be completely discharged without damage. However, when connected in series to form a

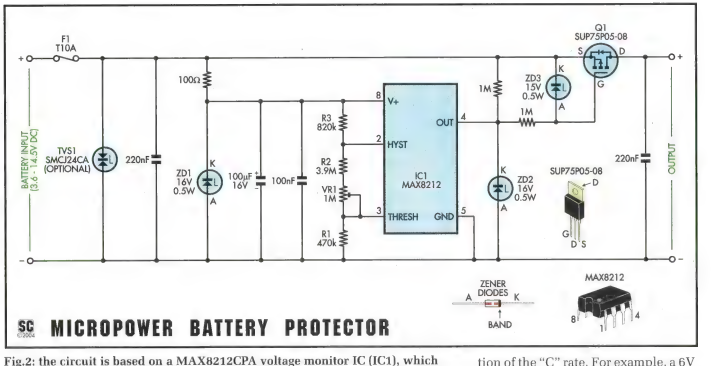

Fig.2: the circuit is based on a MAX8212CPA voltage monitor IC (IC1), which controls Mosfet Q1 to switch the power to the load. Resistor R2 selects the cut-off voltage (see Table 2), with fine adjustment provided by VR1.

battery pack, unequal cell conditions mean that some cells will reach 0V before others. These "weaker" cells are then reverse-charged until all of the energy in the pack is expended. This results in heat damage and electrolyte loss, or worse.

In most cases, the battery will be functional again after a recharge but the reverse-charged cells will have been weakened. And that makes the problem even worse the next time around.

Obviously, the solution to this problem is to disconnect the batteries at some minimum terminal voltage, allowing enough headroom for cell imbalances. For NiCd and NiMH batteries, this is typically 0.9V per cell. For lead-acid batteries, the minimum voltage is dependent on discharge current.

Fig.1 shows the relationship between discharge current and the minimum recommended terminal voltage for both 6V and 12V VRLA batteries – also commonly referred to as "SLA" (sealed lead-acid) batteries.

The discharge capacity of SLA batteries is measured over a 20-hour period and normalised to an amp-hour (Ah) rating. In theory, a 7.2Ah battery can deliver 7.2A for one hour. This is referred to as the "C" or "1C" discharge rate. In practice though, the battery will be exhausted before the hour's end, due to inefficiencies in the electrochemical process.

The horizontal axis represents the discharge current, expressed as a fraction of the "C" rate. For example, a 6V 7.2Ah battery discharged at 3.6A corresponds to a 0.5C rate, with a recommended cut-off voltage of 5.05V.

Note that high-capacity lead-acid car batteries have different characteristics to SLA batteries. Where possible, refer to the manufacturer's datasheets for the recommended cut-off voltage. We've listed a cut-off of 11.4V in Table

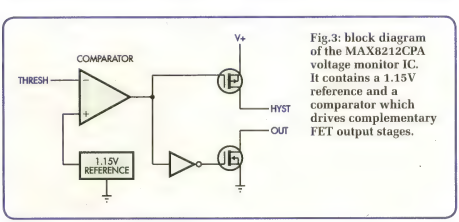

Fig.3: block diagram of the MAX8212CPA voltage monitor IC. It contains a 1.15V reference and a comparator which drives complementary FET output stages.

Main Features

- Disconnects load at preset battery voltage
- Automatically reconnects load when battery recharged
- Ultra-low power consumption (<20µA)
- Miniature size
- 10A maximum rating
- Suitable for use with 4.8-12.5V batteries
- Transient voltage protection (optional)

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- Security systems
- Emergency lighting
- Small solar installations
- Camera battery packs
- Many other low-power applications

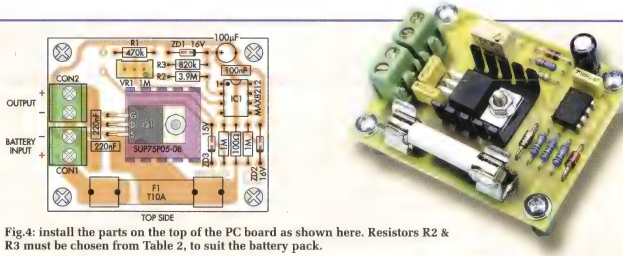

Fig.4: install the parts on the top of the PC board as shown here. Resistors R2 & R3 must be chosen from Table 2, to suit the battery pack.

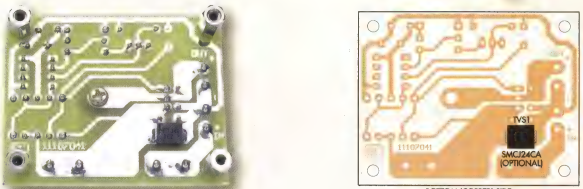

Fig.5: the optional transient voltage suppressor (TVS1) is soldered directly to the copper side of the PC board. It's non-polarised and can go in either way around.

2 simply because at this voltage, there should still be enough energy in the battery to start the engine!

Circuit description

The circuit diagram for the module appears in Fig.2. Battery voltage is applied to the input (lefthand) side of the circuit and switched through to the load on the output (righthand) side via P-channel MOSFET Q1. The gate of this MOSFET is controlled by IC1, a MAX8212 micropower voltage monitor.

Power for the MAX8212 is derived from the battery input, which is filtered using a 100Ω resistor and 100µF & 100nF capacitors before being applied to the V+ input. A 16V zener diode (ZD1) ensures that the supply rail can not exceed the maximum input voltage of the IC (16.5V).

Fig.3 shows the basic internals of the MAX8212. The voltage on the threshold (THRESH) input is connected to the inverting input of a comparator, while a 1.15V reference is connected to the non-inverting input. When the threshold voltage is below 1.15V, the comparator's output is driven towards

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	3.9MΩ 5%	orange white green gold	not applicable
❑	1	3.3MΩ 5%	orange orange green gold	not applicable
❑	1	2.7MΩ 5%	red violet green gold	not applicable
❑	1	1.8MΩ 5%	brown grey green gold	not applicable
❑	1	1.5MΩ 5%	brown green green gold	not applicable
❑	1	1.2MΩ 5%	brown red green gold	not applicable
❑	3	1MΩ	brown black green brown	brown black black yellow brown
❑	1	820kΩ	grey red yellow brown	grey red black orange brown
❑	1	620kΩ	blue red yellow brown	blue red black orange brown
❑	2	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	1	100Ω	brown black brown brown	brown black black black brown

Table 2: Selecting Resistors R2 & R3				
Number of Cells	**Recommended Cut-Off Voltage**	**Reconnect Voltage (nominal)**	**R2**	**R3**
4	3.6V	5.1V	820kΩ	620kΩ
5	4.5V	6.5V	1MΩ	820kΩ
6	5.4V	7.8V	1.2MΩ	1MΩ
7	6.3V	9.2V	1.8MΩ	1.2MΩ
8	7.2V	10.8V	1.8MΩ	1.5MΩ
9	8.1V	11.7V	2.7MΩ	1.5MΩ
10	9V	13.4V	2.7MΩ	1.8MΩ
6V SLA	5.4V	6.8V	1.2MΩ	470kΩ
12V SLA	10.8V	13.4V	3.3MΩ	820kΩ
12V Car Battery	11.4V	13.4V	3.9MΩ	820kΩ

Table.2: select R2 & R3 according to battery type and number of cells. The cut-off voltages shown for SLA batteries are for low-drain applications only. Refer to Fig.1 for more realistic cut-off voltages in higher power applications. Fine adjustment of the cut-off voltage is achieved with the 1MΩ trimpot (VR1), as shown in more detail in Table 3.

the V+ rail and the two FETs are off. Conversely, when the threshold voltage is above 1.15V, the comparator's output is near zero volts, switching the FETs on.

Now back to the circuit – a string of resistors (R1, R2 & VR1) divide down the positive rail such that 1.15V will be present on the "THRESH" input at the desired lower threshold voltage. We've also called this the "cut-off" voltage because this is the point at which Q1 is switched off, disconnecting the battery from the load.

The lower threshold voltage (V_L) can be determined from the formula $V_L = 1.15 \times ((R2+VR1)/R1 + 1)$. Using the values shown and with VR1 in its mid position, the load will be disconnected at approximately: $1.15 \times ((3.9M\Omega + 500k\Omega)/470k\Omega + 1) = 11.9V$.

You will recall that when the threshold voltage is above the trip point, both FETs in the MAX8212 are switched on. This means that the "HYST" output is connected to the positive (V+) rail, shorting out the top resistor in the string (R3), so it is disregarded in the above calculation.

However, when the threshold voltage falls below the trip point, both "HYST" output goes open-circuit, adding R3 into the equation. The rail voltage must now rise higher to generate 1.15V on the "THRESH" input than it did before R3 was in-circuit. This is called the upper threshold or "reconnect" voltage, and it ensures a clean, positive switching action at the output.

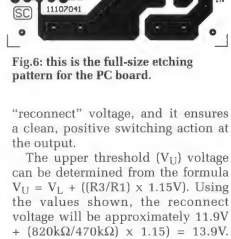

Fig.6: this is the full-size etching pattern for the PC board.

The upper threshold (V_U) voltage can be determined from the formula $V_U = V_L + ((R3/R1) \times 1.15V)$. Using the values shown, the reconnect voltage will be approximately $11.9V + (820k\Omega/470k\Omega) \times 1.15) = 13.9V$. We've used quite a large hysteresis value (2V) because the battery voltage will "rebound" somewhat when the load is disconnected. Ideally, the load should only be reconnected once the battery is recharged or the input power is cycled.

The "OUT" pin of the MAX8212 drives the gate of the P-channel MOSFET (Q1). When the internal FET driving this pin switches on, Q1's gate is pulled towards ground via a 1MΩ resistor, switching it on. Conversely, when the internal FET switches off, Q1's gate is pulled up to the positive rail via a second 1MΩ resistor, switch-

Parts List

1 PC board, code 11107041, 58 x 46mm
2 2-way 5/5.08mm 10A terminal blocks (CON1, CON2)
1 Micro-U TO-220 heatsink (Altronics H-0630, Jaycar HH-8502)
2 3AG PC-mount fuse clips
1 3AG 10A slow-blow fuse
4 M3 x 10mm tapped spacers
5 M3 x 6mm pan head screws
1 M3 nut & flat washer

Semiconductors
1 MAX8212CPA voltage monitor (IC1) (Farnell 205-278)
1 SUP75P05-08 75A 55V P-channel MOSFET (Q1) (Farnell 334-5348)
2 16V 0.5W (or 1W) zener diodes (ZD1, ZD2)
1 15V 0.5W (or 1W) zener diode (ZD3)
1 SMCJ24CA transient voltage suppressor (TVS1) (Farnell 167-563) (optional)

Capacitors
1 100µF 16V PC electrolytic
2 220nF 63V MKT polyester
1 100nF 63V MKT polyester

Resistors (0.25W)
1 3.9MΩ 5%
1 3.3MΩ 5%
1 2.7MΩ 5%
1 1.8MΩ 5%
1 1.5MΩ 5%
1 1.2MΩ 5%
3 1MΩ 1%
1 820kΩ 1%
1 620kΩ 1%
2 470kΩ 1%
1 100Ω 1%
1 1MΩ 25-turn trimpot

Note: the above list includes all values for R2 & R3 shown in Table 1, so you'll have some resistors left over after assembly. Parts with a Farnell catalog number can be ordered from Farnell on 1300 361 005 or visit **www.farnellinone.com.au**. The MAX8212CPA is also available direct from the manufacturer at www.maxim-ic.com

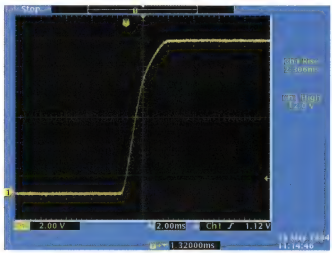

Fig.7: this scope shot shows the rise time of the voltage at the output terminals when a 12V battery is connected to the input. The rounded edge at the top of the waveform is probably due to the battery's response as full load is applied.

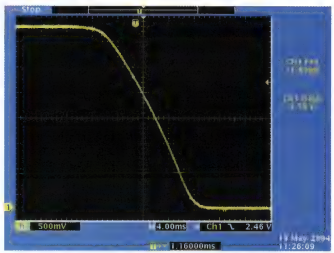

Fig.8: again captured at the output terminals, this waveform shows the voltage fall time when a 4-cell battery pack drops below the preset 3.6V level. Note that it's much longer than the rise time because the MOSFET's gate must be discharged through two 1MΩ resistors.

ing it off. Two zener diodes protect the gate-source junction of Q1 (ZD3) and the drain-source junction of the internal FET of IC1 (ZD2) from potential over-voltage conditions.

Circuit protection

Output overload protection is afforded by a slow-blow fuse (F1) at the input. For light load switching, the size of the fuse can be reduced accordingly, to provide increased protection for the MOSFET.

No reverse polarity protection has been provided. Due to the 10A current rating of this circuit, a series protection diode would reduce the output voltage by as much as 1V and generate considerable heat. Momentary reversal of the battery leads will probably not damage either IC1 or Q1. However, the intrinsic drain-source diode in the MOSFET will conduct, allowing reverse current flow through the load.

For use in a car or other noisy electrical environments, an optional bidirectional transient voltage suppressor (TVS1) can be installed. These devices behave like back-to-back zener diodes but are faster acting and can absorb much more energy. The specified device will clamp the input rail to ±39V peak, protecting the MOSFET and load from all but the most severe high-voltage transients.

Assembly

The assembly is quite straightforward, with all parts mounting on a small PC board coded 11107041 and measuring 58 x 46mm. Install the low-profile components first, using the overlay diagram (Fig.4) as a guide. Take care to align the banded (cathode) ends of all the zener diodes (ZD1-ZD3) as shown.

The values shown for R2 & R3 are suitable for use with a 12V car battery. For other applications, select the appropriate values from Table 2.

Table 3: Max. & Min. Cutoff Voltages

R2	Max. Cut-Off	Min. Cut-Off
3.9MΩ	13.1V	10.6V
3.3MΩ	11.6V	9.2V
2.7MΩ	10.2V	7.7V
1.8MΩ	8.0V	5.5V
1.2MΩ	6.5V	4.0V
1MΩ	6.0V	3.5V
820kΩ	5.6V	3.1V

Table 2: by selecting an appropriate value for R2 and adjusting VR1, cut-off voltages from 13.1V to 3.6V are achievable. Note that with a value of 820Ω for R2, it is possible to achieve a cut-off of 3.1V. However, you should not adjust VR1 for less than 3.6V to avoid overheating Q1.

Note that the MAX8212 (IC1) should be installed without a socket. Make sure that the "notched" (pin 1) end of the IC goes in as indicated on the overlay diagram.

A small "micro-U" style heatsink is needed to keep MOSFET Q1 cool. It is sandwiched between the MOSFET and the PC board, with both items held in place with a M3 x 10mm screw, nut and flat washer.

Bend the MOSFETs leads at 90° about 5mm from the body and trial fit it in position. If the lead bend is correct, the hole in the metal tab will line up with the hole in the PC board without stressing the leads. Apply a thin smear of heatsink compound to the mating surfaces before assembly. Be sure to tighten up the mounting screw before soldering the MOSFET's leads.

The optional transient voltage suppressor (TVS1) can be left until last. It mounts on the copper side of the board and must be positioned precisely as shown in Fig.5 before soldering.

Finally, for operation in high-humidity environments, we recommend that the board be cleaned, thoroughly dried and then coated with a circuit board lacquer. This will prevent problems associated with leakage currents that could affect the accuracy of the threshold voltage setting over time.

Setup & test

In order to set the cut-off voltage accurately, you'll need an adjustable DC bench supply, a multimeter and a small load for the output. A 680Ω

Switching Capacitive Loads & Incandescent Lamps

Capacitive loads can cause huge instantaneous currents to flow at switch-on. One way of reducing this in-rush current is to reduce the switching speed of the MOSFET. To this end, we've used a 1MΩ resistor in series with the gate, which acts with gate capacitance to slow MOSFET turn-on. The result (see Figs.7 & 8) should be sufficient for most general-purpose applications.

In-rush current is an even bigger problem for lamp loads and can not be solved by simply slowing gate turn-on. Tungsten-filament incandescent lamps, for example, exhibit a very low cold-filament resistance – as much as 10-12% of the hot resistance. This means that when an incandescent lamp is switched on, at least 10 times the normal current flows through the filament. After about 5ms, this reduces to about twice the normal level, decreasing slowly until full brilliance at over 100ms later.

We therefore recommend a maximum lamp load of 3.5A (3.4W @ 12V) for use with the Micropower Battery Protector, as higher power lamps may well damage the MOSFET switch.

Note that it is possible to increase lamp load handling by connecting a positive temperature coefficient (PTC) resistor in series with the lamps(s). For example, to switch a 10A lamp load, a 30A PTC with a cold resistance of 0.5Ω and a hot resistance of 0.01Ω would be suitable. Farnell stock a suitable part, Cat. 606-832. This will protect the MOSFET switch and your lamps will last much longer to boot!

0.25W resistor in series with a LED makes an ideal load (see Fig.9).

Hook up the bench supply to the battery input terminals and the load (resistor & LED) to the output terminals, observing correct polarity. Initially, set the input voltage a couple of volts higher than the desired cut-off level.

Now wind VR1 fully anti-clockwise and then power up. The LED should illuminate, indicating that the MOSFET has switched power through to the output.

Next, monitor the input voltage while you carefully adjust your bench supply to the desired cut-off level. That done, wind VR1 slowly clockwise until the LED goes out, indicating that the MOSFET has disconnected the load.

To check the "reconnect" voltage level, slowly increase the input voltage. The MOSFET should switch on again at the expected level, illuminating the LED. Note that there will be some deviation from the listed voltage due to resistor tolerances.

In use, the battery cut-out level will also vary slightly from that set above due to the resistance of the fuse, battery connections, cabling and any other in-line connectors.

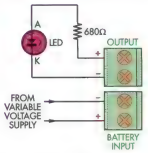

Fig.9: a 680Ω 0.25W resistor in series with a LED makes an ideal load when setting the cut-off voltage – see text.

Housing & wiring

The small size of this module means that, in many cases, it can be built right in to the equipment it protects. Alternatively, it can be installed in a "UB5" size Jiffy box and these are available from all the usual parts suppliers.

All wiring to and from the terminal blocks on the PC should be sized to suit the intended application. When operated at or near the maximum rating, be sure to use extra-heavy duty automotive-type cable.

For use in a car, the unit can simply be wired in-line with the cigarette lighter plug that's connected to the appliance. Alternatively, power should be sourced from a fused terminal in the fuse box. Do not connect the Micropower Battery Protector directly across the vehicle battery! SC

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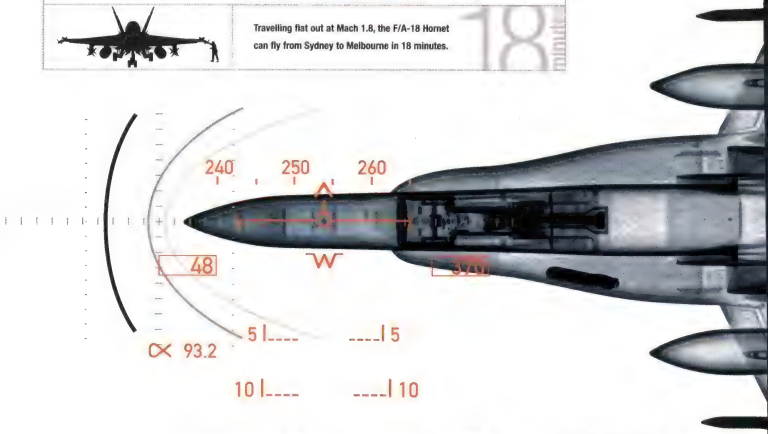

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Pt.1: By JOHN CLARKE

Control your power costs with the:

ENERGY METER

Have you recovered from the shock of receiving your last power bill? Have you resolved to reduce your electricity usage? This Energy Meter lets you accurately monitor energy usage for individual appliances and even figures out what it costs to run them.

IF YOU WANT to save power and reduce costs, you need to know how much power each appliance uses over a period of time. Most appliances don't run all the time, so you need to know the power they use while they are actually running and how much they use over the longer term.

The easiest way to determine that is to use an electronic power meter and this new "Energy Meter" fits the bill nicely. It displays the measured power in Watts, the elapsed time and the total energy usage in kWh. In addition, it can show the energy cost in dollars and cents. As a bonus, it also includes comprehensive brownout protection.

One obvious use for this unit it to show refrigerator running costs over a set period of time, so that you can quickly determine the effect of different thermostat settings. Alternatively, it could be used to show the difference in energy consumption between the summer months and the winter months.

If you have a solar power installation, this unit will prove invaluable. It will quickly allow you to determine which appliances are the most "power hungry", so that you can adjust your energy usage patterns to suit the capacity of the installation. And there

are lots of other uses – for example, the unit could be used to determine the cost of pumping water, the running costs of an aquarium or even the cost of keeping your TV set on standby power, so that it can be switched on via the remote control.

Standby power

The cost of standby power is something that most people never think about. However, there are lots of appliances in your home that continuously consume power 24 hours a day, even when they are supposedly switched off. These appliances include TV sets, VCRs, DVD players, hifi equipment and cable and satellite TV receivers. They remain on standby so that they are ready to "power up" in response to a command from the remote control.

Then there are those devices that are powered via a plugpack supply. These devices include modems, some printers, portable CD players and battery chargers (eg, for mobile telephones). However, simply switching these devices off when not in use is not the complete answer because their plugpacks continue to draw current – unless, of course, they are switched off at the wall socket.

Some high-power appliances also continue to draw current when they are not being used. For example, most microwave ovens have a digital clock which operates continuously and the same applies to some ovens. Typically, the standby power usage for each of these appliances is about 2W.

What else? Well, let's not forget computers. Then there are those appliances which must always be on, otherwise there's no point having them. These include cordless telephones, digital alarm clocks, burglar alarms and garage door openers. Do a quick audit of your house – you will be quite surprised at how many appliances you have that are either permanently powered or operating on standby power.

By using the Energy Meter, you can quickly monitor these devices and find out which are the energy wasters. Perhaps when you learn the results, you will be persuaded to turn some of these devices off at the wall or even do away with them altogether!

Brownout protection

A bonus feature of the SILICON CHIP Energy Meter is the inclusion of brownout protection. This means that, when it's not being used to check energy consumption, the unit can be used to provide brownout protection for a selected appliance.

Basically, a brownout occurs when the mains voltage goes low (ie, much lower than the nominal 240VAC) due to a supply fault. This can cause problems because motor-driven appliances (eg, washing machines, air-conditioners, dryers, refrigerators, freezers and pumps) can be damaged by a low mains supply. If the supply voltage is low, the motor can fail to start (or stall if it's already running) and that in turn can cause the windings to overheat and burn out.

In operation, the SILICON CHIP Energy meter can switch off power to an appliance during a brownout and restore power when the power is returned to normal. The power can either be restored immediately the brownout condition ends or after a delay of 18-24 minutes. This delay feature is ideal for use with refrigeration equipment, as it allows the refrigerant to settle if the brownout occurred during the cooling cycle.

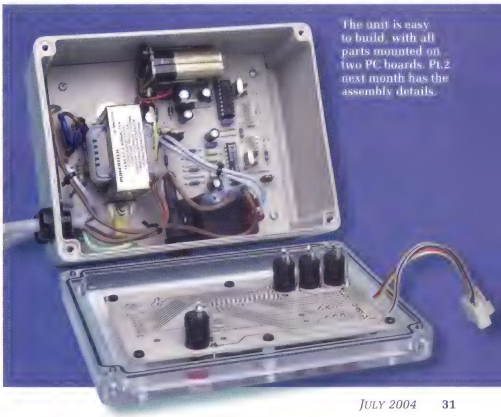
Using the Energy Meter

As shown in the photos, the SILICON CHIP Energy Meter is housed in a rugged plastic box with a clear lid. This plastic case is important because the internal circuitry operates at mains potential. Two 10A mains leads are fitted to the unit – one to supply power from the mains and the other to supply power to the appliance.

The unit is easy to use: simply plug it into the mains and plug the appliance into the output socket.

Main Features

- Displays power in Watts
- Displays energy usage in kWh
- Displays measurement period in hours
- Displays energy cost in dollars and cents
- Brownout detection and power switching
- LCD module shows several readings simultaneously
- Calibration for power, offset and phase
- Adjustment of cents/kWh for cost reading
- Adjustment of brownout voltage threshold, calibration, hysteresis & duration.
- Optional delayed return of power after brownout is restored to normal voltage



Specifications

- Wattage resolution 0.01W
- Maximum wattage reading 3750.00W
- Kilowatt hour resolution 1Wh (0.001kWh)
- Maximum kWh reading 99999.999kWh
- Cost/kWh resolution ..... 0.1 cent
- Maximum cost/kWh reading $9999.99
- Cost/kWh setting from ..... 0-25.5 cents
- Timer resolution ..... 0.1h (6 minutes)
- Maximum timer value 9999.9h
- Timer accuracy (uncalibrated) typically ..... ±0.07%
- Maximum load current ..... 10A (15A surge)
- Reading linearity ..... 0.1% over a 1000:1 range
- Frequency range of measurement ..... 40Hz to 1kHz
- Battery current drain during back-up 10mA
- Accuracy ..... Depends on calibration (error can be <0.5%)
- Accuracy drift with temperature ..... 0.002%/°C
- Brownout voltage detection accuracy after calibration ..... ±2%
- Brownout return delay ..... 18-24 minutes
- Wattage calibration adjustment ..... 0.0244% of reading per step (±2048 steps)
- Zero Offset adjustment ..... 0.12% of reading per step
- Current monitoring resistance ..... 1% tolerance, 20ppm/°C coefficient

An LCD display is visible through the lid of the case and the only exposed parts are four mains-rated switches. These switches are used to set the display modes, reset values and (initially) to set the calibration values.

In use, the Energy Meter is simply connected in-line between the mains supply and the appliance to be monitored. The LCD shows two lines of information and this information includes: (1) the elapsed time; (2) the power consumption in watts; (3) brownout indication; and (4) the energy consumption in kWh (kilowatt-hours).

The elapsed time is shown on the top, lefthand section of the display and is simply the time duration over which the energy has been measured. This is shown in 0.1 hour increments from 0.1h (ie, 6 minutes) up to 9999.9h. That latter figure is equal to just over 416 days or 1 year and 51 days, which should be more than enough for any application!

After it reaches this maximum elapsed time, the unit automatically begins counting from 0.0h again. Alternatively, the timer can be reset to 0.0h at any time by pressing the Clear switch.

The power consumption figure (watts) is displayed to the right of the elapsed time and is updated approximately once every 11 seconds. This has a resolution of 0.01W, with a maximum practical reading of 3750.00W (ie, equal to the power drawn by a 15A load with a 250V supply). A 10A load will give a reading of about 2400W, depending on supply voltage.

Immediately beneath this figure is the total energy consumption (in kWh) since the measurement started. This has a range from 0.000kWh to 99999.999kWh, with a resolution of 1Wh. The maximum value represents over 4.5 years of energy consumption for an appliance drawing 2500W continuously.

This reading can be reset to 0.000kWh by pressing the Clear switch. In this case, the switch must be held closed for about four seconds before the RESET is indicated on the display.

Finally, brownout indication is shown in the lower lefthand section of the display. It displays "SAG" if the mains level drops below the selected voltage for a set time, with the unit also switching off the power to the connected appliance.

Alternatively, under normal power conditions (ie, no brownout), the SAG display is blanked and power is supplied to the appliance.

Function switch

Pressing the Function switch on the front panel changes the display reading, so that the energy reading is shown in terms of cost instead of kWh. Once again, this reading can be reset to $0.00 by pressing the Clear switch. The maximum reading is $9999.99 but this is unlikely to ever be reached.

Pressing the Function switch again toggles the energy reading to kWh again.

Holding down the Function button switches the Energy Meter into its calibration modes. There are eight adjustment modes available here and these can be cycled through by holding the button down or selected in sequence with each press of the Function switch. We'll take a closer look at the various calibration modes in Pt.2 next month.

Making power measurements

OK, now that we've looked at the main functions of the Energy Meter, let's see how we go about making power measurements.

In operation, the Energy Meter measures the true power drawn by the load. It is not affected by the shape of the waveform, provided that the harmonics do not extend above 1kHz and the level does not overrange.

In a DC (direct current) system, the power can be determined by measuring the applied voltage (V) and the current (I) through the load and then multiplying the two values together (ie, P = IV). Similarly, for AC (alternating current) supplies (eg, 240V mains), the instantaneous power delivered to a load is obtained by multiplying the instantaneous current and voltage values together. However, that's not the end of the story when it comes to

average power consumption, as we shall see.

Fig.1 shows a typical situation where the current and voltage waveforms are both sinewaves and are in phase with each other (ie, they both pass through zero at the same time). In this case, the instantaneous power waveform is always positive and remains above zero. That's because when we multiply the positive-going voltage and current signals, we get a positive result. Similarly, we also get a positive value when we multiply the negative-going voltage and current signals together.

The average (or real) power is represented by the dotted line and can be obtained by filtering the signal to obtain the DC component. In the case of in-phase voltage and current waveforms, it can also be obtained by measuring both the voltage and the current with a meter and multiplying the two values together. For example, the voltage shown in Fig.1 is a 240V RMS AC waveform and this has a peak value of 339V. The current shown is 10A RMS with a peak value of 14.4A. Multiplying the two-RMS values together gives 2400W, which is the average power in the load.

Note that, in this case, the power value is the same whether we average the instantaneous power signal or multiply the RMS values of the voltage and current. Multimeters are calibrated to measure the RMS value of a sinewave, so if a sinewave has a peak value of 339V, the meter will read the voltage as 240V (ie, 0.7071 of the peak value).

For non-sinusoidal waveforms, only a "true RMS" meter will give the correct voltage and current readings. RMS is shorthand for "root mean square", which describes how the value is mathematically calculated. In practice, the RMS value is equivalent to the corresponding DC value. This means, for example, that if we apply 1A RMS to a 1Ω load, the power dissipation will be 1W – exactly the same as if we had applied a 1A DC current to the load.

The waveforms in Fig.1 are typical of a load that is purely resistive, where the current is exactly in phase with the voltage. Such loads include electric light bulbs and electric radiators.

By contrast, capacitive and inductive loads result in out-of-phase voltage and current waveforms. If the load is capacitive, the current will lead the voltage. Alternatively, if the load is inductive, the current will lag the voltage.

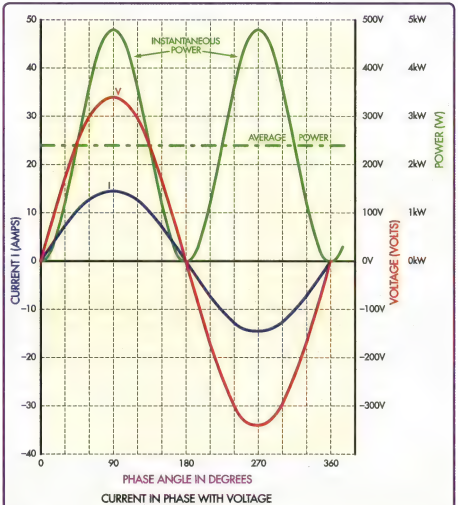


Fig.1: this graph shows the voltage (V) and current (I) waveforms in phase with each other. Note that the instantaneous power is always positive for this case.

Inductive loads include motors and fluorescent lamps. The amount that the current leads or lags the voltage is called the power factor – it is equal to 1 when the current and voltage are in phase, reducing to 0 by the time the current is 90° out of phase with the voltage. Calculating the power factor is easy – it's simply the cosine of the phase angle (ie, cosϕ).

Lagging current

Fig.2 shows the resulting waveforms when the current lags the voltage by 45°. In this case, the resulting instantaneous power curve has a proportion of its total below the zero line. This effectively lowers the average power, since we have to subtract the negative portion of the curve from the positive portion.

And that's where the problems start. If we now measure the voltage (240V) and current (10A) using a multimeter and then multiply these values together, we will obtain 2400W just as before when the two waveforms were in phase. Clearly, this figure is no longer correct and the true power is, in fact, much lower, at 1697W.

This discrepancy arises because the power factor wasn't considered. To correct for this, we have to multiply our figure of 2400W by the power factor (ie, cos45° = 0.7071). So the true power is 2400 x 0.7071 = 1697W.

These calculations become even more interesting when the current leads or lags the voltage by 90° as shown in Fig.3 – ie, we have a power factor of 0. In this case, the voltage and current waveforms still measure

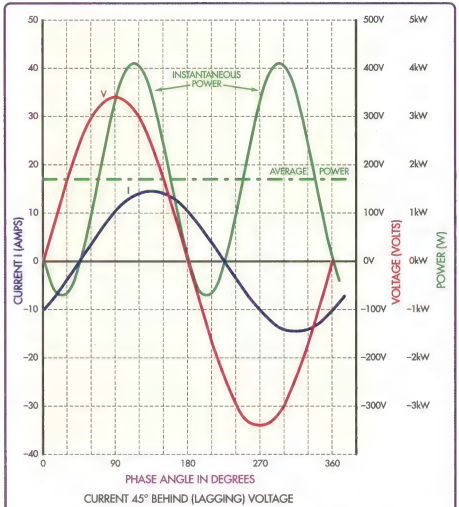


Fig.2: here's what happens when the current lags the voltage by 45°. In this case, the resulting instantaneous power curve has a proportion of its total below the zero line, effectively lowering the average power.

240V and 10A respectively when using a multimeter but the power dissipation is now zero. This is because the same amount of instantaneous power is both above and below the zero line.

This means that even though there is 10A of current flowing, it does not deliver power to the load!

Alternatively, we can use our formula to calculate the true power dissipation in the load. In this case, we get 240 x 10 x Cos90° = 0 (ie, cos90° = 0). So once again, we get a power dissipation of 0W, despite the fact that the current is 10A and we have 240V applied to the load.

Other waveform shapes such as produced by phase control circuits, where the waveform is "chopped", present even more difficulties when it comes to making power measurements. However, the SILICON CHIP Energy Meter overcomes these problems by averaging the instantaneous power signal over a set interval (11s) to obtain the true power.

The result is an accurate power measurement which takes into account the phase angle and the shapes of the voltage and current waveforms.

Converting the measured power dissipation (Watts) into energy consumption (kWh) is straightforward. This is simply the average power used by the appliance over a 1-hour period. So if an appliance draws 1000W continuously for an hour, its energy consumption will be 1000Wh, or 1kWh.

Specialised IC

The SILICON CHIP Energy Meter is based on a special "Active Energy Metering IC" from Analog Devices, designated the ADE7756AN. Fig.4 shows the main internal circuit blocks of this IC and also shows how it has been connected to the mains, to make voltage and current measurements.

As can be imagined, the internal operation of this IC is quite complicated and it has a host of features, some of which are not used in this design. If you want to find out more about this IC, you can download a complete data sheet (as a pdf file) from **www.analog.com**.

Most of the features and adjustments available in the ADE7756AN IC are accessed via a serial interface. This communications interface allows various registers to be accessed and altered and also allows them to receive processed data.

As shown on Fig.4, there are two input channels – one to monitor the voltage and the other for the current. Amplifier 1 (Amp1) is used to monitor the load current but it doesn't do this directly. Instead, it monitors the voltage developed by passing the load current through a 0.01Ω resistor (R1).

The maximum dissipation within this resistor at 10A is 1W, which gives an expected 30°C temperature rise above ambient. For this reason, we have specified a low-temperature coefficient resistor to minimise resistance changes as the temperature rises.

In operation, Amp1 can be set for a gain of 1, 2, 4, 8 or 16 and for a full-scale output of 1, 0.5 or 0.25V. These values are set by writing to the appropriate registers within the IC via the serial communication lines. In this circuit, the gain is set at 1 and the full-scale output at 250mV.

The 250mV range was chosen to suit the 100mV RMS (141.4mV peak) that's developed across resistor R1 when 10A is flowing through the load (which is in series). It also allows sufficient headroom for a 15A current to be measured – equivalent to 150mV RMS across R1, or 212mV peak.

Amp2 is similar to Amp1 except that its full-scale output voltage is fixed at 1V. Only the gain can be set and in this case, we have set the gain of 4.

As shown, the Active input from the mains is divided down using a 2.2MΩ and 1kΩ resistive divider. This divided output is at 113.5mV RMS (161mV peak) for a 250V input and this is then fed directly to Amp2. As a result, the signal level at the output will be 454mV RMS, or 644mV peak, well within the 1V full-scale output capability of this stage.

The circuit is even capable of ca-

tering for situations where the mains voltage reaches 280V RMS (396V peak). In this case, the voltage from the resistive divider will be 180mV peak, which gives 720mV peak at the amplifier's output.

Both Amp1 and Amp2 have provision to zero the offset voltage at their output (this is the voltage that appears at the output when the amplifier's inputs are both at ground or 0V). Of course, an ideal amplifier would have an output offset of 0V but that doesn't happen in practice.

In this application, however, we don't have to worry about trimming out the offset voltages because a high-pass filter is included in the signal chain (following multiplier 1). This filter prevents the offsets from affecting the power reading but note that offset adjustment would be required to accurately measure DC power in other circuit applications.

A/D converters

The output signals from the amplifier stages are converted to digital values using separate (internal) analog-to-digital converters (ADC1 & ADC2). For those interested in the specifications of this conversion, the sampling rate is 894kHz and the resolution is 20 bits. An analog low-pass filter at the front of each ADC rolls off signals above 10kHz, to prevent errors in the conversion process which might otherwise occur if high-frequency signals were allowed to pass into the ADC.

The output of each ADC is then dig-

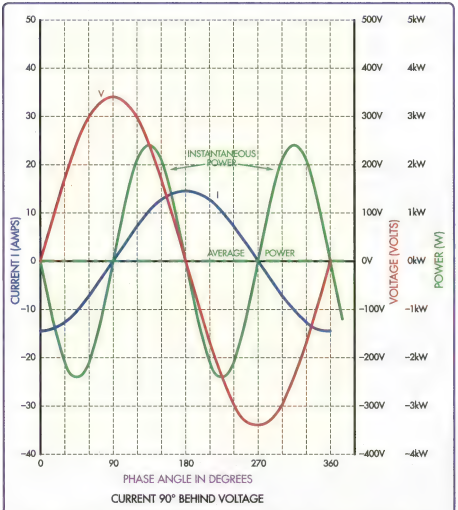


Fig.3: it gets even more interesting when the current lags (or leads) the voltage waveform by 90°. In this case, the voltage and current waveforms still measure 240V and 10A respectively but the average power dissipation is now zero. This is because the same amount of instantaneous power is both above and below the zero line.

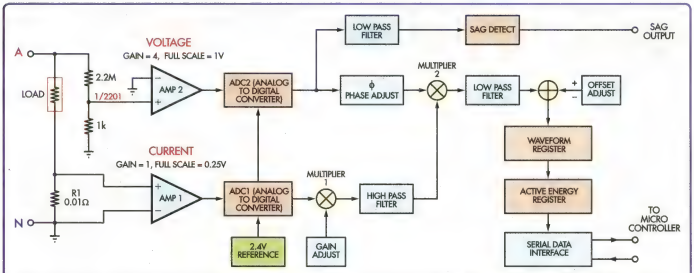


Fig.4: this block diagram shows the main components of the ADE7756AN Active Energy Metering IC and shows how it is connected to the 240VAC mains supply. Two internal op amp circuits monitor the current (Amp 1) and voltage (Amp 2) signals and the sampled values are then fed to separate analog-to-digital converters.

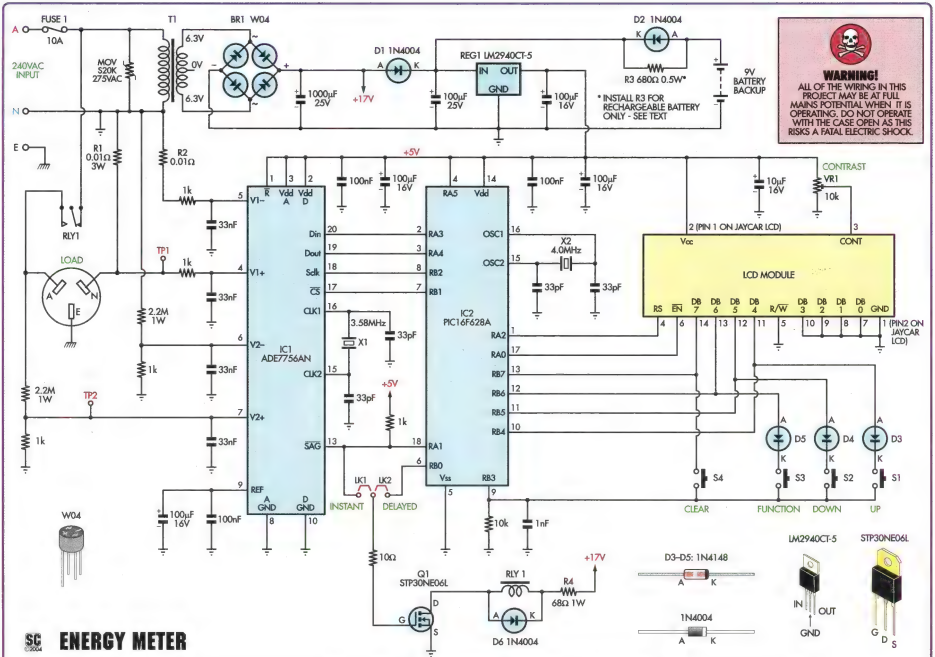


Fig.5: the circuit uses a PIC microcontroller to process the data from the ADE7756AN Active Energy Metering IC and to drive the LCD module.

itally filtered with a low-pass filter to remove noise. This filter does not affect 40Hz to 1kHz signals but rolls off frequencies above about 2kHz.

Next, ADC1's output is applied to a multiplier. This stage alters the digital value fed into it according to a "gain adjust" value that's applied to the multiplier's second input. This gain adjust value can be changed by writing to this register and in our circuit, it's used to calibrate the wattage reading to its correct value.

A High-Pass Filter (HPF) stage is then used to process the adjusted signal from the multiplier. This removes any DC offsets in the digital value and applies the resulting signal to one input of Multiplier 2.

ADC2 operates in a similar manner to ADC1 and also includes a low-pass filter (LPF) stage. Another LPF stage then rolls off the signal at frequencies above about 156Hz. This effectively removes any extraneous high-frequency components in the signal before it is fed to the SAG detection circuit. This detection circuit monitors the voltage level and outputs a SAG signal if the voltage drops below the level set in the SAG register.

As well as going to the LPF stage, the signal from ADC2 is also fed to a phase compensation circuit (Phase Adjust). This stage can change the signal phase relative to the signal from ADC1 and is included to compensate for any phase differences which may be caused by any current and voltage-measuring transducers (not applicable here).

Immediately following this stage, the signal is applied to the second input of Multiplier 2. This effectively multiplies the current and voltage signals to derive the instantaneous power value. This is then filtered using another low-pass filter, to produce a relatively steady value, although it does allow some ripple in the output since it does not completely attenuate AC signals and only rolls off signals above 10Hz.

The resulting power value is then mixed in the Offset Comparator with an offset adjustment, to give a zero reading when there is no current flowing through R1. Its output is stored in the Waveform Register, the contents of which are continuously added to the Active Energy register at an 894kHz rate.

Finally, the data in the Active Energy Register can be retrieved via the Serial Data Interface. Note that the values retrieved from this register will vary, because of the ripple allowed through the LPF at the output of Multiplier 2. However, these variations are less noticeable if the period between each retrieval is made as long as possible, so that any ripple can be integrated out over time.

For this reason, we have selected a retrieval interval of about 11 seconds and this removes most of the variation. That's about the maximum practical limit, as a longer period could cause the register to overrange when high powers are being measured.

WARNING!

This circuit is directly connected to the 240VAC mains. As such, all parts may operate at mains potential and contact with any part of the circuit could prove FATAL. This includes the back-up battery and all wiring to the display PC board.

To ensure safety, this circuit MUST NOT be operated unless it is fully enclosed in a plastic case. Do not apply power to this device with the lid of the case removed.

This is not a project for the inexperienced. Do not attempt to build it unless you are completely familiar with mains wiring practices and construction techniques.

Circuit details

OK, so the way in which the ADE7756AN chip works is rather complicated. Fortunately, we don't have to worry too much about this, since the complicated stuff is all locked up inside the chip.

Refer now to Fig.5 for the full circuit details. Apart from the ADE7756AN chip (IC1), there's just one other IC in the circuit – a PIC16F628A microcontroller (IC2). This microcontroller processes the data from IC1 and drives the LCD display module. And that's just about all there is to it – apart from the power supply circuitry and a few other bits and pieces.

IC1 operates at 3.58MHz as set by crystal X1 and this frequency determines all the other operating rates, such as ADC sampling and the phase variation. In addition, the device operates from a single +5V supply rail, although its inputs at pins 4, 5, 6 & 7 can go below the 0V level.

In operation, the sampled current and voltage waveforms are applied to the balanced inputs of the internal amplifiers – ie, to V1+ and V1- for Amp1 (current) and to V2+ and V2- for Amp2 (voltage). These balanced inputs are provided so that any common mode (ie, noise) signals at the inputs are cancelled out.

However, in order to do this, both inputs to each amplifier must have the same input impedance and signal path. So, for the voltage signal, both inputs of Amp2 are connected to a 2.2MΩ and 1kΩ voltage divider and these in turn are connected across the Active and Neutral lines.

Similarly, the current monitoring inputs are both connected to series 0.01Ω and 1kΩ resistors but note that only one of these (ie, R1) carries the load current. This resistor is rated at 3W, while the non-load current carrying resistor (R2) simply consists of a short length of fine-gauge copper wire. R2 is necessary to mimic the noise picked up by R1.

All inputs are filtered to remove high-frequency hash above about 4.8kHz by connecting 33nF capacitors to ground (ie, from pins 4, 5, 6 & 7).

Note that the whole circuit is referenced to the mains Neutral, with the 0V rail for both IC1 and IC2 connected to this line. **However, because the circuit is connected directly to the mains, it must be treated as live and dangerous (as can happen if Active and Neutral are transposed in the house wiring).**

IC1's reference voltage at pin 9 is filtered using parallel-connected 100µF and 100nF capacitors. This provides a stable reference voltage for the ADCs and is typically 2.4V. However, variations between individual ICs could result in a reference voltage that's 8% above or below this value but this is taken care of by the calibration procedure.

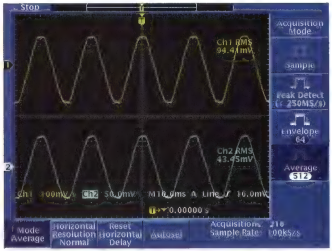


Fig.6: the top trace in this scope shot is the voltage that appears on pin 7 of IC1 (TP2). This is the sampled mains voltage from the 2.2MΩ and 1kΩ resistive divider. The lower trace is the current waveform at pin 4 of IC1, resulting from a 4.3A load. This produces a 43.45mV RMS signal across the 0.01Ω current sensing resistor (R1).

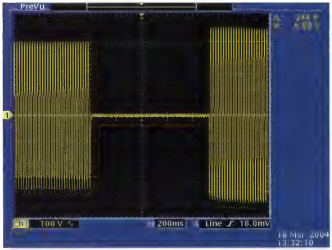


Fig.7: this scope shot, captured at the output of the Energy Meter, shows the operation of the brownout feature. In this case, the brownout protection is set to switch off below 203V RMS (288V peak) and power is restored only when the voltage increases by the hysteresis level (35V RMS or 50V peak) – ie, to 238V RMS.

WARNING: these two scope waveforms are shown to explain the operation of the circuit. DO NOT attempt to monitor these waveforms yourself – it is too dangerous.

The SAG output appears at pin 13 and is normally held high via a 1kΩ pull-up resistor. This, in turn, holds Mosfet Q1 on and so relay RLY1 is also normally on (assuming link LK1 is in position). Conversely, when a power brownout occurs, the SAG output goes low and Mosfet Q1 and RLY1 both turn off.

The SAG output from IC1 also drives RA1 (pin 18) of IC2 and this does two things. First, it "instructs" the microcontroller to send the SAG indication data to the LCD display when a brownout is detected. Second, it allows IC2 to provide the optional delayed turn-on feature after a brownout via RB0 and LK2 (ie, LK2 used instead of LK1).

When the SAG output goes low, RB0 also immediately goes low and turns off Q1 as before. However, when the brownout ends, RB0 remains low and only goes high again after an 18-24 minute delay to switch on Q1 and RLY1 and thus restore power to the appliance.

Note that the relay contacts are used to break the power to the load by opening the Active connection. When there is no brownout, the relay is energised and the supply is connected to the load.

IC1 also connects to IC2 via its serial interface and these lines are labelled Data In, Data Out, Serial Clock and Chip Select (pins 20, 19, 18 & 17, respectively). In operation, IC2 uses these lines to program the registers within IC1 and to retrieve the monitored power data.

Microcontroller IC2 also drives the LCD module using data lines RB7-RB4. These lines also connect respectively to switch S4 (direct) and to switches S3-S1 via diodes D3-D5. These diodes are necessary to prevent the data lines from being shorted together if more than one switch is pressed at the same time.

In operation, IC2 can determine if a switch is closed (ie, pressed) by first setting its RB7-RB4 data lines high and then checking the RB3 input which connects to the commoned side of the switches. If none of the switches is pressed, the RB3 input will be held low via the associated 10kΩ resistor to ground. Conversely, if a switch is pressed, the RB3 input will be pulled high via that switch (and its associated diode, if present).

The microcontroller then determines which switch is closed by setting all data lines low again and then setting each data line high (and then low again) in sequence. The closed switch is the one that produces a high at RB3.

IC2's RA2 & RA0 outputs (pins 1 & 17) control the register select (RS) and enable (EN-bar) inputs on the LCD module, to ensure that the data is correctly displayed. Trimpot VR1 adjusts the LCD's contrast by setting the voltage applied to pin 3 of the module.

A 4MHz crystal (X2) sets IC2's clock frequency. This crystal determines the accuracy of the 0.1hr timer and the watt-hour calibration. However, frequency adjustment has not been included since the crystal's untrimmed accuracy is better than the accuracy provided by IC1 for the wattage reading.

Power supply

Power for the circuit is derived from the mains via transformer T1. Its 12.6V AC secondary output is rectified using bridge rectifier BR1 and the resulting DC rail filtered using a 1000μF capacitor. This rail is then fed through rectifier diode D1, filtered using a 100μF capacitor and fed to 3-terminal regulator REG1.

REG1 provides a stable +5V rail for IC1, IC2 and the LCD module. **Note, however, that this +5V rail must also be regarded as being at mains potential (as must all other parts in this circuit, including the back-up battery). It might have a low DC voltage but it can also be sitting at 240VAC!**

Note also that we have specified a

low dropout regulator here and this has been done for two reasons. First, it allows the +5V rail to be maintained for as long as possible when the mains supply falls – important for maintaining the supply during a brownout. Second, this regulator was designed for automotive use and is capable of suppressing transient voltages of up to 60V at its input.

This latter feature is useful for mains supply circuits, where there are likely to be transients during lightning storms. In addition, a Metal Oxide Varistor (MOV) connected between Active and Neutral at the mains input has been included to suppress transient voltages above the normal mains supply.

The supply rail for relay RLY1 is derived from the output of the bridge rectifier (BR1). This rail is fed to the relay via a 68Ω 1W resistor, which reduces the voltage to about 12V.

Diode D6 protects Mosfet Q1 from damage by quenching any back-EMF voltage spikes that are generated when RLY1 turns off.

Back-up battery

An optional 9V back-up battery has also been included in the power supply and this is connected to REG1's input via diode D2. This back-up power is useful if the energy consumption of an appliance is to be measured over a long period of time (eg, weeks or months), since it maintains the active energy register values and allows the timer to continue counting if there is a blackout.

You can use either a standard battery or a rechargeable nicad battery to provide back-up power. If a nicad battery is used, resistor (R3) is installed to provide trickle charging from the output of D1.

Most applications will not require battery back-up, since you will just want to measure the energy consumption over a relatively short period. In this case, the accumulated energy reading will be lost when the mains power is switched off. However, all the settings (ie, the SAG parameters, offset and power calibration, cost per kWh and phase, etc) are retained when the mains power is off, as these are stored in a permanent memory.

That's all we have space for this month. Next month, we will give the complete construction and calibration details. SC

Parts List

1 PC board, code 04107041, 138 x 115mm
1 display PC board, code 04107042, 132 x 71mm
1 front panel label, 138 x 115mm
1 sealed ABS box with clear lid, 165 x 125 x 75mm (Altronics H0328 or equivalent)
1 12.6V 7VA mains transformer (Altronics M2853L) (T1)
1 12V SPDT 30A 250VAC relay (Altronics S4211) (RLY1)
1 LCD module (DSE Z 4170, Altronics Z 7000A, Jaycar QP 5515)
1 S20K 275VAC Metal Oxide Varistor (MOV)
1 3.58MHz crystal (X1)
1 4MHz crystal (X2)
1 18-pin DIL socket (for IC2)
1 M205 safety fuse holder (F1)
1 M205 10A fast blow fuse
1 10A mains cord with plug
1 1-metre length of 10A mains cord
1 10A mains line socket
2 cordgrip grommets for 6mm diameter cable
4 mains-rated pushbutton momentary-close switches (Jaycar SP 0702)(S1-S4)
1 4-way 0.1-inch pitch pin header
1 6-way 0.1-inch pitch pin header
1 4-way 0.1-inch header plug
1 6-way 0.1-inch header plug
4 stick-on rubber feet
1 9V battery (optional – see text)
1 connector plug & lead for 9V battery (optional, see text)
1 U-shaped bracket to suit 9V battery (optional, see text)
1 M3 x 6mm screw (optional)
1 M3 metal nut (optional)
6 M3 x 10mm Nylon countersunk screws
4 M3 x 10mm screws
6 M3 x 6mm screws
6 M3 tapped 12mm long spacers
4 M3 metal nuts
2 M3 star washers
1 14-way single in-line pin header (for Altronics and DSE LCD module); or
1 7-way dual in-line header (for Jaycar LCD Module)
1 3-way single in-line header
1 shorting plug for header
1 3mm diameter solder lug (or crimp lug)
3 6.4mm insulated spade connectors
2 2.8mm spade connectors
1 100mm length of 4-way rainbow cable
1 100mm length of 6-way rainbow cable
1 40mm length of 0.2mm enamelled copper wire
1 400mm length of 0.7mm tinned copper wire
1 150mm length of hookup wire
1 50mm length of 16mm diameter heatshrink tubing
1 50mm length of 2.5mm diameter heatshrink tubing
5 50mm long cable ties
12 PC stakes

Semiconductors

1 ADE7756AN Active Energy Metering IC (IC1)
1 PIC16F628A-20P programmed with wattmetr.hex (IC2)
1 LM2940CT-5 low dropout 5V regulator (REG1)
1 STP30NE06L logic Mosfet (Q1)
1 W04 1.2A bridge rectifier (BR1)
3 1N4004 1A diodes (D1,D2,D6)
3 1N914, 1N4148 switching diodes (D3-D5)

Capacitors

1 1000µF 25V PC electrolytic
1 100µF 25V PC electrolytic
4 100µF 16V PC electrolytic
1 10µF 16V PC electrolytic
3 100nF MKT polyester
4 33nF MKT polyester
1 1nF MKT polyester
4 33pF NPO ceramic

Resistors (0.25W 1%)

2 2.2MΩ 1W 400V
1 10kΩ
5 1kΩ
1 680Ω 0.5W (install only if back-up battery is rechargeable)
1 68Ω 1W
1 10Ω
1 .01Ω 3W resistor (Welwyn OAR-3 0R01) (Farnell 327-4718) (R1)
1 10kΩ horizontal trimpot (code 103) (VR1)

DICK SMITH ELECTRONICS

Benchmark

July 2004

NEW

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LAN Cable Tester

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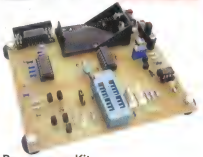

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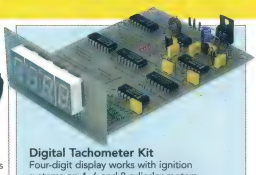

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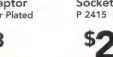

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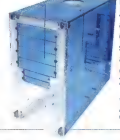

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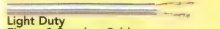

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A POOR MAN'S Q METER

by Maurie Findlay, MIEAust

A simple jig, made from a few inexpensive components, allows you to make measurements which usually require an expensive Q meter. In conjunction with a signal generator and an electronic voltmeter, inductance and "Q" can be measured quite accurately.

Experimenters, and even professionals, setting up a test bench have to think hard before buying test instruments.

Depending on the special interest, items such as a multimeter, regulated power supply, counter, oscilloscope, RF and AF signal generators would come high on the list.

Money can be saved by building test gear described in SILICON CHIP over the years. Sometimes out-of-date equipment from schools and government departments can be overhauled and brought into service.

But for most people, purchase of a Q meter would probably be pretty low on the priority list.

There are at least two reasons for this. Inexpensive hand-held bridges can measure inductance reasonably accurately, provided the values are not too small (say below 10 µH). Second, the selective components used in modern equipment usually come in block form such as ceramic, crystal or mechanical filters with the characteristics specified by the manufacturer.

No longer does the designer have to specify the inductance and Q of a whole series of coils to make up a filter for, say, the intermediate frequency section of a receiver.

On the other hand, inductances to a fraction of a µH are used in the signal frequency circuits of both transmitters and receivers for filters, tuning, coupling and decoupling circuits.

Inductors used for coupling between tuned circuits and to active devices are usually quite critical but they are not adjustable.

So this discussion is about a simple test jig which, used in conjunction with a signal generator and an electronic voltmeter, allows the inductance and Q of small coils to be measured accurately by resonance with a known value capacitor.

It comes into its own when dealing with inductors below about 10µH. It can easily be adapted to measure a range of inductance by altering the value of the capacitor.

Most readers will regard this as an ideas article rather than a constructional project to be copied component for component. The model illustrated is just one of many ways the basic idea can be used.

Now let's get down to the principles and then the practice.

When an inductor is placed in parallel with a capacitor to form a tuned circuit, the resonant frequency is given by:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

where f, L and C are in the basic units of Hertz, Henries and Farads.

If we know f and C, the equation can be rearranged to give the value of l in microhenries (µH) when C is in picofarads (pF) and the frequency in megahertz (MHz). C is known and fixed. We vary the frequency and calculate L.

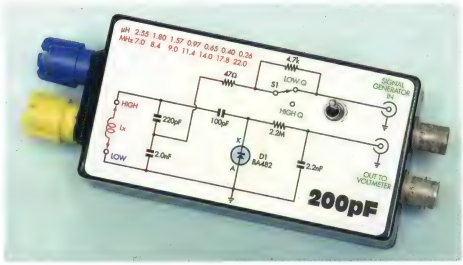
This can be done from the formula, or more conveniently from a graph plotting inductance against frequency.

For convenience, we present graphs for C of 50pF, 200pF and 500pF.

C is the value of the capacitor which effectively appears between the "HIGH" and "LOW" terminals of the test jig (see circuit diagram) and is made up of two capacitors in series, the one connecting to the "LOW" terminal being about 10 times the value of the capacitor connecting to the "HIGH" terminal.

Accuracy of the readings depends on the accuracy of the latter.

Mica and polystyrene capacitors can be obtained with a 1% tolerance but these days you won't find such items at every hobby store!



With less than a dozen components, a digital multimeter and pratically any RF signal generator you can measure Q and inductance very easily. The old-style point-to-point wiring is housed in a shielded metal box.

In general terms, ceramic capacitors are not suitable for this job. This capacitor is the only critical component required for the project.

We have found capacitors with tolerance marked in ex-military equipment or you may have to ask a favour of a friend with access to laboratory equipment.

It is unlikely that you will be able to get the values of C required with a single capacitor and various combinations of serial and parallel may be needed.

The value of two capacitors in series is calculated by multiplying the two values and dividing this figure by the sum of the two values (remember resistors in parallel?).

For 220pF in series with 2000pF this works out to be 198.2 pF. Not bad, but you can always select a nominal 2000pF which is a little on the high side.

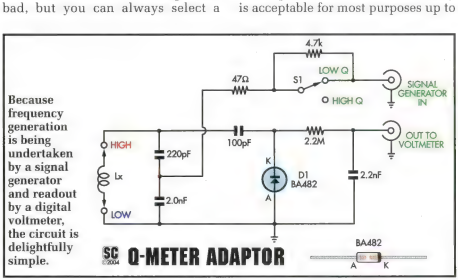
For most purposes, the reading from the graph will be accurate enough. If you need greater accuracy, calculate the value of inductance from the formula.

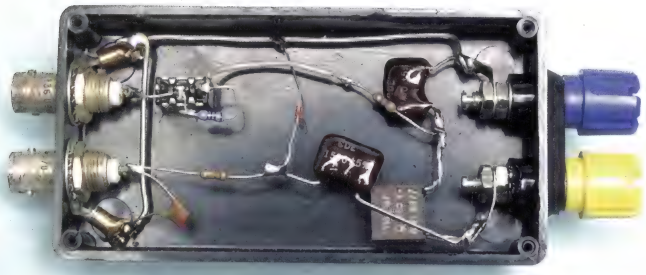
For measurements to be made, it is necessary to excite the tuned circuit formed by fixed C and the unknown L and measure its response.

To do this some of the RF energy must be fed into this tuned circuit. It is not possible to do this without having some effect on both the frequency and the losses of the tuned circuit. In practice, the errors are acceptable provided the frequency and the natural Q of the tuned circuit are not too high.

Some expensive commercial Q meters go to a great deal of trouble to reduce errors. With the simple techniques used here, the accuracy is acceptable for most purposes up to

Because frequency generation is being undertaken by a signal generator and readout by a digital voltmeter, the circuit is delightfully simple.





Inside the box: four capacitors, three resistors, a diode and a switch make up the total component count. BNC connectors have been used for the oscillator input and multimeter output but these are not mandatory.

about 300MHz and a Q of 200.

Standard practice for Q meters is to excite the tuned circuit by inserting a small value, non-inductive resistor in series with the inductor under test. The output of the signal generator is applied across this resistor sometimes, through an RF transformer. The instrument measures the RF current through the resistor and the Q (magnification factor) can be measured by an RF voltmeter across the circuit.

The simple system used here couples into the tuned circuit partly by reactive and partly by resistive components. It fits in with the usual signal generator that is designed to feed into 50Ω.

Modern generators usually have a maximum output of 1V RMS and the older types 100mV with x2 switch if used without amplitude modulation.

The suggested circuit, shows a switch labelled "HIGH Q' and "LOW Q". This switch is left in the "HIGH Q" position if you have a high output signal generator and a sensitive voltmeter in order to keep the coupling between the generator and the tuned circuit low. However, with low Q tuned circuits and low output signal generators. you can at least get a reading, even if is less accurate.

Don't worry about the signal generator not being correctly terminated. In this case, it doesn't matter.

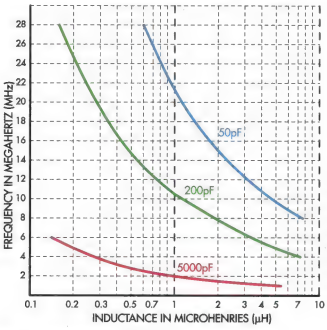
Again, looking at the suggested circuit, the detector is in a shunt diode arrangement using a BA482 low capacity, low loss silicon diode. There are other diodes which will do the job just as well.

The output of the detector is fed to a connector and then to a DMM set to a DC scale. Most DMMs have an input resistance of 10MΩ or greater. The older valve electronic voltmeters usually have a 0-1.5V scale while the most sensitive range for modern DMMs may be 200mV.

The net result of losses brought about by the exciting signal and the loading of the detector is that the measured Q of very efficient inductors will be less than the true value. The same applies to expensive commercial Q meters, although some of the best of them do have built-in circuits to partially compensate.

Because we don't know the precise value of the RF used to excite the tuned circuit, the value of Q has to be measured by indirect means.

Use is made of the universal selectivity curve. (See Terman "Electronic and Radio Engineering" and others.) The curve has the same general shape, regardless of the value of Q and the frequency and can be of great value when designing tuned filters with



In many cases, you'll be able to read values straight off these graphs without having to resort to formulas. We've shown three easily-arranged capacitance values.

special characteristics.

For the purposes of measuring Q we are interested in the response at three frequencies.

These are: the maximum; the frequency lower than the maximum at which the response is 0.707 (-3dB); and the frequency above the maximum at which the response is 0.707.

The difference between the two –3dB frequencies is the bandwidth. The Q of the circuit is the centre frequency divided by the bandwidth.

If you are making a lot of measurements, it soon becomes a matter of routine and, given a pocket calculator, you can work very quickly.

There will be cases where you do not need to know the precise value of Q and you can zip through a series of readings by noting that the reading of the voltmeter is above a predetermined value.

The Q meter jig pictured here was originally set up to check the inductors for low-pass filters used in HF radio transceivers operating between 2 and 20MHz. Inductance values between about 0.2 and 3.0μH were used and the values needed to be within about 5%. A parallel capacity of 200pF brought the resonant frequencies within the range of even the older HF signal generators.

To cover a wide range of inductance values, there is always the possibility of installing switched capacitors or a calibrated variable capacitor but the jig is so simple that two or more separate units may be just as easy. For very small value inductors as may be used in VHF equipment a switched arrangement may not be practical.

Having made up the jig in a physical form that suits your purpose, find a low Q inductor, ideally of known value, and work out the resonant frequency.

With the signal generator and voltmeter connected, tune the signal generator for maximum indication. The signal generator should be set for maximum output. Note the reading of the DMM. If too low for convenience you can reduce the value of the 4.7kΩ resistor as required. The lower the value the greater the reduction in the measured Q.

Similarly, you can increase the reading of the voltmeter slightly by reducing the value of the series resistor, marked 2.2MΩ on the circuit, to about 1MΩ.

At 47Ω in series with a 50Ω output signal generator (ie, the switch in the "LOW Q" position), a coil with a true Q of 250 will measure only about 50. If you are only concerned with the inductance value, this may not matter.

Having adjusted the set-up to suit your instruments, the routine for measurement goes like this:

Inductance

- Connect voltmeter and signal generator,
- Connect unknown inductor,
- Tune signal generator for maximum meter deflection and note the frequency, and
- Read the inductance from the graph for the corresponding value of C or calculate the inductance from the formula.

Q Value

- Using the signal generator's attenuator, reduce the output by 3dB,
- Note the meter reading,
- Return the signal generator's attenuator to the setting for full output,
- Adjust the signal generator's frequency higher, to the point where meter reading drops to the -3dB point,
- As above but on the low frequency side. Subtract this frequency from the one above to obtain the bandwidth;
- Q is then the centre frequency divided by the bandwidth.

If your signal generator has a digital readout or you can connect a counter to read frequency, very good accuracy can be obtained.

Happy measuring ! **SC**

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Restoring Old Dials, Front Labels

Restoring antique or vintage radios often means rebuilding or repairing damaged cases. But what do you do if a panel, label or dial is damaged or missing? You cheat a bit and create a vintage replica, 2004 style!

No matter how professionally constructed an electronic project is inside, others judge it by the exterior appearance. Hand drawn labels can look awful!

The good news is a computer enables anyone to create professional custom labels and dials in a short time. These techniques are excellent when restoring old radios too, as spare parts can be impossible to find.

Computer software helps

All that's needed is a graphics application like Photoshop Elements. It's priced at about $200 (or included with many digital cameras). Elements is considered by many to be the among the most versatile graphics and digital software, only surpassed by the full version of Photoshop (which sells for considerably more but is very much more powerful).

Copy or restoration projects will also need a scanner or a camera to copy originals. Scanners regularly sell for less than $100 these days (especially USB scanners); "good enough" digital cameras have also come down dramatically in price.

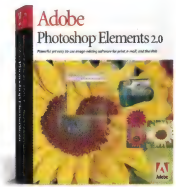
Existing designs can be copied or custom projects created for printing on a home printer. You can also get true photographic prints at a photo lab; even have transparencies made or the design screen printed onto plastic, glass or metal.

You don't have to be an artist if some lateral thinking is employed. For example, shapes like rectangles and curves can be drawn perfectly using the lasso tool or the rectangle or ellipse tool if appropriate, then filled with any colour. If you only need a portion of a curve, the rest can be cut away.

This guide is based on Photoshop 7 on a PC or Mac, however the techniques apply to any graphics application with layers.

Layers?

Layers can be thought of as a number

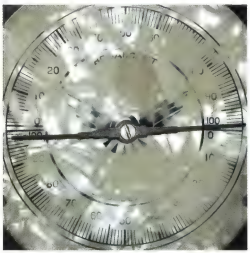


of pages of tracing paper, with the original drawing at the bottom. You can draw on a new layer and still see the original art below but not affect it in any way. Layers also allow parts of the design to be on individual layers, - especially in different colours, allowing considerable creative control.

Many projects need a custom meter scale. On most commercial panel meters, there is a clear bezel which unclips to give access to the factory scale plate. This plate can be scanned or photographed as a template for the new dial (see photo).

Often two tiny screws hold the scale in place – be careful not to bend the meter pointer as you slide the scale out. And don't lose the screws!

Place the digital (scanned/photo-graphed) image into the graphics application (in RGB mode) and adjust the image size of the dial to 100% or 1:1 scale. The image resolution settings need to be at least 200 dpi, with 300 dpi optimum and 400 dpi the



A back-lit radio dial from a 1936 Melodious is missing text and details.

The restored copy printed onto a transparency is sandwiched in place for a perfect result.

Panels and

By Kevin Poulter

upper limit. Higher resolution makes no improvement on clarity but takes a lot more memory and hard drive space and slows the entire project down.

The meter shown needed a new voltage range and colour-coded scale. The most important aspect of this meter scale is the curve.

Start by making a new layer to draw the curve on, using the circular lasso tool, stretched to an oval football shape. By not altering the original image, it remains as a guide until the new design is completed. You can draw a lasso curve shape as close as possible, then change it to precisely match, using 'transform selection'. Alternatively, keep drawing shapes until you have the right one - it's not hard with a little practice. The lasso shape can be moved to exact alignment using the arrow keys on the PC keyboard.

Complex shapes may need hand drawing using a lasso. Zoom in to a huge enlargement then hand draw the shape required.

Once the oval shape is drawn, fill it with white. Draw a similar shape for the bottom of the curve. Hit the delete, leaving a circular band, ready to add the colours.

(Extra Photoshop techniques and tools like guidelines can help, however they are too numerous to expand on, so check the software instruction manual.)

Now select the magic wand and click on the white curve. A selection of 'marching ants' will appear around the entire white curve. Initially you are only adding the red on the far left of the scale, so the circular selection needs reducing.

Select the lasso tool, hold down Alt (Windows) or Option (Mac) and draw around the unwanted area. When this subtraction is completed, fill the small left section with red. Repeat these steps for each colour.

Set the colour to black and type the numbers and text. Fill the bottom layer with white to make a background and merge all the layers. The new dial is completed. The graphic can be printed on a desktop printer or at a photo lab and then laminated, or glued onto the existing scale plate.

The original meter dial . . .

. . . and the new one, produced on a PC, printed on a colour inkjet and glued directly to the meter face.

Dials and labels

Restoration of a radio dial or label employs very similar techniques. In the next example, the Melodious radio circa 1936 is in good order, but the scale on the back-lit dial is substantially missing (see photo on opposite page).

To avoid the cost and difficulty of reprinting a new dial, photograph the damaged original, make a restored replica in the computer, output onto a transparency or clear film (eg, overhead projector film) in the printer, then sandwich it in place. The original remaining printing on the dial will probably need to be removed before sandwiching the new transparency. If the dial body appears to be resistant to petrochemicals, metho, turps or even thinners can be used. If in doubt, test on an area that won't be seen.

Making a clear film transparency of your artwork can be easier than expected. Some inkjet printers will print directly onto clear film or professional photo labs can make a transparency. Alternatively, print your restored label to normal paper and use it as the master to copy onto clear film at some libraries or schools. A number of photocopiers will also copy onto clear film.

With back-lit dials, these techniques can result in a very believable result.

Reproduction labels and dials for old radios can be made employing the same techniques as the dial described earlier. Photograph or scan the original, or another collector's better example, then use it as the template for the new one.

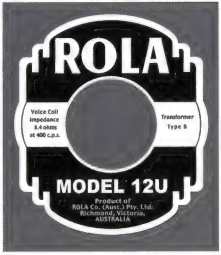
Rola speakers

Rola was Australia's largest speaker manufacturer based in Richmond (Vic). The top performing twelve-inch model (12U) was made in February 1951. Rola in their wisdom date-stamped most of their loudspeakers, which is very useful to reasonably gauge the age of radios with a Rola speaker installed.

After more than 50 years, the 12U speaker is near perfect, except for the metallised paper label and the paint around it. Any attempt to remove the label to repaint the body results in a confetti of fragments, so it needs replacement before there is nothing left to copy.

Firstly a photograph was taken 'square-on' and loaded into a Photoshop page. Where curves and shapes are similar on each side or corner, you only need to make one of each, as the

The original label on a 1951 Rola speaker.



After copying and restoring in Photoshop.

As the label was originally printed on a metallised paper, vignetted tones were added and printed on a metallic-look photographic paper.

others are made instantly by copying, flipping and moving them into position.

Like the meter, draw the top curve shape and fill it with white. Conversely, the black areas are drawn and filled with black. When this label was originally produced, it was hand-drawn, so you'll soon find the original is far from 100% symmetrical. The conclusion - a modern PC can be used to quickly and easily make a more precise label!

As all text was originally hand drawn as well, it was fortunate nearly all the lettering matched Helvetica font, with huge spacing between characters. The Rola brand name was a unique design by a graphic artist, so it was enlarged considerably and traced around with the lasso too like other complex graphics.

When all the shapes and text were completed, the layers were merged and saved as a .tiff. This was sent on CD to a photo lab, for printing on a new Kodak paper with a metallic look that catches the light. Then the finished label was laminated with a thin clear film to ensure it lasts indefinitely.

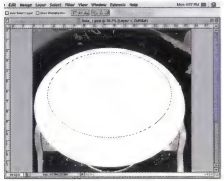
If your artwork is a replacement for a valve radio dial, it can be screen-printed onto glass or acrylic, for a result barely discernible from the original. The minimum production run at a screen-printers is around ten identical glass dials. While this is typically $300, collectors often join forces to have a batch made, splitting the costs so each share only $30.

Entire front panels for custom projects can be printed onto paper or film and held in place with a perspex panel.

If printing direct to a transparency, one idea employed by manufacturers is to print the text back to front, so the plain side can face outside. The text will then never wear off.

Whatever your label and dial requirements, a desktop computer can be used to produce top-class results. After all, that's what most manufacturers now use. **SC**

Here's how it was done using Photoshop



Copying the graphics involves drawing shapes onto a new layer and filling with colour, in this case white. The first football shape oval is drawn and filled, then another oval drawn below it.

When the second oval shape is drawn, press the delete key on the keyboard. This leaves the top curve filled with white. Remove any unwanted white in the lower area of the graphic.

The finished white curve. From here, restore other areas by making a new layer to draw a copy of another section. Then fill the new section with black or white as required. It's important to note once a corner or repeated shape has been drawn, it can be duplicated and flipped easily to save redrawing. When all design elements are complete, add the text and merge layers for a completed graphic.

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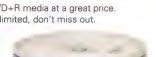

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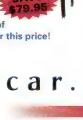

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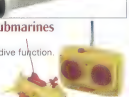

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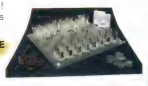
SAVE $5

Cat. GT-3005 **$24.95**



Flashing Shot Glass

- Just the thing to alert the bartender!
- A red LED flashes when you slam it down.

Cat. GH-1150 **$3.95**

Full Feature Car Alarm

- Great protection for your vehicle.
- Includes back-up battery siren.
- Code rolling remote controls.
- Central door locking control. **Was $199**

SAVE $20

Cat. LA-9005 **$179.00**

Mini Cold Cathode Fluorescent (CCFL) Tubes

- Create great lighting effects in your car or home.
- 12VDC powered. • Flickerless starting.
- Each tube is powered by an inverter (sold separately). • Two sizes available 100mm and 300mm.

100mm tubes:

White SL-2860 Red SL-2861 Blue SL-2862 Green SL-2864 UV SL-2865

All 100mm Tubes: $11.95ea

Inverter to Suit 100mm Tubes

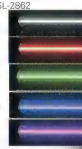
Cat. SL-2868 **$9.95**

300mm tubes: White SL-2880 Red SL-2881 Blue SL-2882 Green SL-2884 UV SL-2885

All 300mm Tubes: $19.95ea

Inverter to Suit 300mm Tubes

Cat. SL-2888 **$12.95**



Remote Control Jammer

- Strike back at the remote control hog in the family!
- Works with most IR remote controls.

Cat. GH-1084 **$9.95**

Remote not included

Farting Salt and Pepper Shakers

- Entertain and embarrass at your next dinner party.
- They make a fart sound when tipped upside down.

Cat. GH-1080 **$19.95**

Remote Controlled Secret Farter

- A high tech replacement for the Whoopee cushion!
- Remote controlled so no-one will know you're responsible.

Cat. GH-1088 **$19.95**

These Realistic Fart Sounds

Hand Held Farting Keyring

- Let off a great fart sound at the touch of a button!
- Every practical joker should have one.

Cat. GH-1082 **$9.95**

THAMES & KOSMOS SCIENCE EXPERIMENTERS KITS

Jaycar now stocks a range of well developed, and highly advanced scientific learning kits for High School, Technical Institution, and University Students. They are not like the low cost Chemistry set-type kits in toy stores. They are of excellent quality with superior documentation written by academics. Each kit is supplied with everything necessary to complete the projects outlined in the instruction manual & any safety equipment required (eg. safety goggles).

Operating Fuel Cell Powered Car

•Discover how fuel cells and electrolysis work.
•Contains an actual working fuel cell!
•30 experiments covered in a 96 page manual.

Cat. KT-2500
$299.00

Alternative Energy Model House

•Discover alternative energy in a realistic way.
•Experiments on model house representing real world application.
•Multiple experiments covered in a 96 page manual.

Cat. KT-2502
$299.00

Micro TREK - Journey into Microspace

•Discover hidden creatures and structures in the microscopic world.
•High quality die cast 100x - 900x microscope included
•A journey of discovery outlined in a 52 page manual.

Cat. KT-2520
$169.95

Mind's Eye

•Explore the science of optical illusions and human perception.
•94 experiments in a 100 page manual.

Cat. KT-2504
$149.00

CHEM C1000

•Explore a broad range of chemical phenomena with hands-on lab experience.
•75 experiments in a 40 page manual.

Cat. KT-2516
$149.95

CHEM C101

•Learn the basics of chemistry and its application far beyond a laboratory.
•30 experiments in a 32 page manual.

Cat. KT-2510
$59.95

Kite Dynamics

•Design, build, and fly a kite, while learning the theory behind it.
•9 experiments covered in a 32 page manual.

Cat. KT-2514
$99.95

Solaro

•Build solar powered models based on real world vehicles.
•7 models to build covered in a 32 page manual.

Cat. KT-2522
$99.95

Balloon Adventures

•Discover the science behind balloons, and build balloon powered models.
•24 experiments in a 32 page manual.

Cat. KT-2506
$59.95

Crystal Pro

•Learn about crystal composition, and even grow crystals.
•14 experiments covered in a 32 page manual.

Cat. KT-2518
$59.95

Detector Radio

•A radio with no power! Based on early crystal radio principles.
•20 experiments in a 32 page manual.

Cat. KT-2508
$59.95

Bubble Builder

•Make giant and tiny bubbles, soap film domes, bubbles in bubbles & more.
•35 experiments in a 32 page manual.

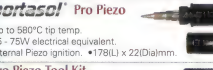
Cat. KT-2512
$59.95

portasol® Gas Soldering Tools

Jaycar is serious about quality, and soldering products are no exception.

Portasol is a brand that is recognised worldwide for its quality and reliability. We are proud to stock a range of their products, to provide you with the very best they have to offer.

portasol® 50 Soldering Iron



Cat. TS-1300
$39.95

•350°C fixed tip temp. •35W electrical equivalent.
•Flint ignitor in cap. •196(L) x 26(W) x 19(D)mm.

portasol® Technic

Cat. TS-1305
$49.95

•Up to 450°C tip temp. •10-60W electrical equivalent.
•Flint ignitor in cap. •170(L) - 19(Dia)mm.

Gas Glue Gun

•2Hr operating approx.
•Internal piezo ignition.
•Uses 11mm glue sticks.

Cat. TH-1330
$69.95

portasol® Pro Piezo

•Up to 580°C tip temp.
•15 - 75W electrical equivalent.
•Internal Piezo ignition. •179(L) x 22(Dia)mm.

Cat. TS-1310
$89.95

portasol® Super Pro

•Up to 580°C tip temp.
•25 - 125W electrical equivalent.
•Internal Piezo ignition. •234(L) x 25(Dia)mm.

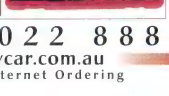
Cat. TS-1320
$109.00

Pro Piezo Tool Kit

•Quality storage case.
•Cleaning sponge and tray.
•2.4mm tip. •Hot air blow tip.
•Hot knife tip. •Hot air deflector
•Flame tip.

Cat. TS-1318
$119.00

Super Pro Tool Kit



•Quality storage case.
•Cleaning sponge and tray.
•2.4mm tip. •4.8mm tip. •Hot air blow tip.
•Hot knife tip. •Hot air deflector.

Cat. TS-1328
$149.00

MECHATRONICS HAS LANDED AT JAYCAR!

See our 2004 catalogue pages 144 - 149 or our website for full details.

Spider Coupler Set

•Connects a motor to a shaft that may be slightly misaligned.
•Accepts 6.35mm (1/4") shafts.

Cat. YG-2782 $6.50

Aluminium Hub with Set Screws

•Coupling from the gear to a shaft.
•Accepts a 6.35mm (1/4") shaft and suits a 22.5mm gear.

Cat. YG-2784 $9.95

12Pc Gear Set 48 Pitch

•Moulded in hard nylon with generous shaft bosses.
•Industrial quality, lubrication free.

Cat. YG-2780 $79.95

Low Cost Motor / Gearbox Set

•6 available speed/torque combinations.
•3V, 12000RPM motor.

Cat. YG-2730 $9.95

6.35mm (1/4") Shaft Coupler

•Sturdy solid steel sleeve.
•Hex drive set screws for fastening.

Cat. YG-2790 $9.50

Socket Chain to suit Sprocket Set

•Hard nylon industrial quality chain, 900g max tension.
•300mm length, easily shortened or lengthened with pliers.

Cat. YG-2788 $19.95

14 Piece Sprocket Set

•Hard nylon, suits chain shown on left.
•Most have 6.35mm (1/4") bore, 900g max tension.

Cat. YG-2786 $59.95

Fixed Gearbox with Motor

•2.5mm drive shaft diameter, 100mm long.
•1.5 - 3VDC power, 6650RPM output.

Cat. YG-2725 $7.50

Solutions² BRAND ROBOTIC PRODUCTS

Robotic Wheel Kit

•Simplifies mechanical mounting requirements for small robotic projects.
•4.5 - 12VDC, 200RPM, 3.6kg/cm torque.
•35(W) x 64(dia)mm wheel size.

Cat. YG-2796 $99.95

Motor Mind C Single or Dual DC Motor Controller

•Control 10 - 24V brushed DC motors.
•Single or dual independent motor control options.
•40 pin DIP package, 4A max continuous current.

Cat. YG-2792 $109.95

Carrier Board for BASIC Stamp™

•Provides quick and easy connectivity to Parallax BASIC Stamp™ 24 pin products.
•Includes programming port and I/O wiring points.
•7 - 30VDC, up to 2.25A per motor.

Cat. YG-2794 $119.95

BOOKS

Combat Robots

•Covers many subjects to build, compete and win! •Contains actual designs and CD-ROM plans. •300+ pages, 230 x 180mm.

Cat. BT-1363 $49.95

PIC Robotics

•Teaches you all to get started. No assembly language programming required.
•374 pages
•230 x 185mm.

Cat. BT-1367 $49.95

Robotics, Mechatronics, and AI

•An extremely thorough book from beginner to serious constructor.
•100s of designs included.
•297 pages, 230 x 150mm.

Cat. BT-1370 $110.00

Robot Builders Sourcebook

•If you want robotic parts, this will tell you where to get them.
•Over 2500 sources, a must for every enthusiast.
•711 pages, 280 x 215mm.

Cat. BT-1365 $49.95

DC MOTORS TO SUIT MANY APPLICATIONS

Standard DC Motors

•Hardened drive shafts, sintered bearings, quality commutator brushes.
•2.3mm drive shaft, full data sheets supplied.

6V 9,000RPM

•80g/cm torque @ 2A max efficiency.
•51(L) x 27.6(dia)mm.

Cat. YM-2712 $6.95

12V 8,100RPM

•180g/cm torque @ 1.5A max efficiency.
•57(L) x 27.6(dia)mm.

Cat. YM-2716 $8.95

12V 6,500RPM

•1300g/cm torque @ 4.5A max efficiency.
•71(L) x 35.8(dia)mm.

Cat. YM-2718 $12.95

High Power DC Motors

•Astonishing speed and power
•Long life design.
•Hard steel shafts.

12V 11,800 RPM

•6 - 12VDC operating voltage.
•0.42kg/cm torque @ 4.7A max efficiency.

Cat. YM-2770 $14.95

6V 20,000 RPM

•3 - 6VDC operating voltage.
•0.32kg/cm torque @ 13.5A max efficiency.

Cat. YM-2772 $18.95

12V 18,800 RPM

•6 - 12VDC operating voltage.
•0.67kg/cm torque @ 12.8A max efficiency.

Cat. YM-2774 $18.95

12V 9,700 RPM

•6 - 12VDC operating voltage.
•0.60kg/cm torque @ 6A max efficiency.

Cat. YM-2776 $19.95

12VDC Reversible Gearhead Motors

•Work equally well in forward or reverse.
•12VDC rated, 4.5 - 18VDC operating voltage.

2.1kg/cm Torque

•70RPM @ 390mA max efficiency.
•62:1 gear ratio.

Cat. YG-2732 $12.95

12kg/cm Torque

•36RPM @ 1380mA max efficiency.
•244:1 gear ratio.

Cat. YG-2734 $19.95

50kg/cm Torque

•140RPM @ 11.7A max efficiency.
•1000:1 gear ratio.

Cat. YG-2738 $39.95

Single Channel DVR with Stereo Sound and 120GB HDD

- Removable hard disk carry case.
- On screen display.
- 720 x 576 max resolution (PAL).

Cat. QV-3066 **$799.00**

2.4GHz Wireless Modules

- Utilise wireless communication between your AV appliances.
- Small power supply circuit and hardware required.

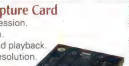
Transmitter Was $34.95 — SAVE $5 — Cat. QC-3590 **$29.95**

Receiver Was $49.95 — SAVE $10 — Cat. QC-3592 **$39.95**

4 Channel Video Capture Card

- Real time digital compression.
- Digital motion detection.
- Simultaneous record and playback.
- Up to 768 x 576 pixel resolution.

Was $349.95



Cat. QV-3056 **$299.95** — SAVE $50

2.4GHz Wireless A/V USB Receiver

NEW! 2004

- A 2.4GHz wireless receiver, with composite video out, and a USB connection.
- Supports up to 3 cameras at once!
- Uses 2.4GHz cameras shown on right.

Cat. AR-1835 **$249.00**

Vari-Focal Camera Lenses

- Simple adjustment of focus and zoom.
- Locking mechanism for stability.
- CS mount.

NEW! 2004 — Cat. QC-3345

QC-3345	3.5-8.0mm	**$79.00**	
QC-3347	2.8-12.0mm	**$99.00**	Cat. QC-3347
QC-3349	6.0-60mm	**$169.00**	Cat. QC-3349

Melcom 8 Sector Alarm Installer Kit with Dialler

- 1 x Melcom 8 sector panel with dialler.
- 1 x LCD keypad.
- 3 x Proton quad PIR's.
- 1 x 7Ah backup battery.
- 1 x Power supply.
- 1 x Strobe light.
- 1 x Indoor siren.
- 2 x Reed / magnet assemblies.
- Siren cover / siren speaker. •4 x Deterrent stickers.
- 100m roll 6 core approved alarm cable. •1 x 30m roll 2 core cable.

Was $749.00

Cat. LA-5428 **$699.00**

SAVE $50

4 Channel DVR with Audio and 120GB HDD

- Quad or switching display.
- Digital motion detection.
- 704 x 564 max resolution (PAL).

Cat. QV-3067 **$899.00**

IP / WEB Based Surveillance

The new age in remote surveillance is here. These units feature integrated WEB servers, so given a fixed IP address, you can take a look at what is going on from any internet access point in the world!

Colour CMOS Camera

- 640 x 480 max resolution.
- Adjustable video quality.

Ideal for child care centres, schools and more.

Cat. QC-3390 **$349.00**

4 Input Capture Box

- Accepts up to 4 composite video inputs.
- Integrated digital motion detection.

Cat. QC-3392 **$349.00**

2.4GHz Transmitting Colour Camera

- Suitable for use with the USB receiver shown to the left.
- This is the same camera used for the baby monitor, and can be used for extra monitoring locations.

NEW! 2004

Cat. QC-3281 **$189.00**

Vari-Focal Camera Lenses with Auto Iris

- Automatic iris adjustment for optimum light level.
- Simple adjustment of focus and zoom.
- CS mount.

NEW! 2004 — Cat. QC-3350

QC-3350	3.5-8.0mm	**$119.00**	
QC-3352	2.8-12.0mm	**$159.00**	Cat. QC-3352
QC-3354	6.0-60mm	**$199.00**	Cat. QC-3354

PLUG N VIEW 2 Camera System with Switching Monitor

- Plug N View takes the hassle out of installation.
- Only a single cable between monitors and cameras.
- 12" B&W 4 channel switching monitor.
- 2 x Outdoor B&W CCD cameras.

Was $449

SAVE $50 — GREAT VALUE!

Cat. QC-3732 **$399.00**

16 Channel DVR with Audio and 120GB HDD

- Switching or superior multiplexing operation.
- Digital zoom.
- Picture in picture. •256 level digital motion detection.
- Multiple frame rates & compression ratios. •Not stocked in all stores, call store first for availability.

Cat. QV-3068 **$1,599**

Colour Video Doorphone with 5.6" LCD Monitor

NEW! 2004

- Large LCD for superior picture clarity.
- Optional electronic door strike control.
- Quality colour CMOS camera.
- Supplied with mounting and wiring hardware.

Cat. QC-3612 **$499.00**

Colour CMOS Camera with Telescope or Microscope Mount

NEW! 2004

- Display images from a telescope or microscope on a monitor or TV.
- 350,000 effective pixels.
- Automatic white balance.
- More than 230 TV lines.
- 1/50 to 1/15000 shutter speed.
- Composite video out.
- Plugpack or battery powered.

Microscope Camera

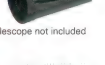
Cat. QC-3242 — Cat. QC-3242 **$199.00**

Telescope Camera

Cat. QC-3240 — Cat. QC-3240 **$189.00**

Telescope not included

Zoom Camera Lens



- 3 internal DC motors for control of zoom, focus, and iris.
- 6.0 - 36.0mm focal length.
- 56(W) x 76(H) x 82(L)mm.

Cat. QC-3358 **$299.00**

NEW! 2004

PLUG N VIEW 4 Camera System with Quad Monitor

- Plug N View takes the hassle out of installation.
- Only a single cable between monitors and cameras.
- 12" B&W 4 way quad display monitor.
- 4 x Outdoor B&W CCD cameras.

Was $899

SAVE $100

Cat. QC-3730 **$799.00** — GREAT VALUE!

NEW HARDCORE ELECTRONICS!

This section is dedicated to what's-new for the Hardcore Enthusiast.

1W Luxeon LEDs

- Up to 120 Lumens per LED!
- 100,000 hours life expectancy.
- Fully dimmable.
- Superior ESD protection.
- New Luxeon 1W LED driver kit on back page!

Red
Cat. ZD-0400 $14.95

Green
Cat. ZD-0402 $16.95

Orange
Cat. ZD-0401 $14.95

Blue
Cat. ZD-0403 $16.95

White
Cat. ZD-0404 $16.95

1W Economy LEDs

- Our own in-house brand of high power LEDs.
- Just as bright, at a cheaper price.
- 100,000 hours life expectancy.
- Fully dimmable.

Red
Cat. ZD-0410 $10.95

Green
Cat. ZD-0412 $12.95

Blue
Cat. ZD-0414 $12.95

White
Cat. ZD-0416 $12.95

GPO Mains and Earth Leakage Tester

- Check all mains outlets for correct wiring.
- Identifies no connection and wrong connection.
- Tests earth leakage circuit breakers with selectable 10 - 100mA leakage current.

Cat. QP-2000 **$19.95**

TDA1905 5W Audio Amp IC BARGAIN!

- High quality amp IC.
- Internal muting facility.
- 16 pin DIP package.
- Very low noise.
- Data sheets available.
- Limited quantity.

Cat. ZL-3600 **$3.95**

NEW SMD COMPONENTS

Many of our new SMD semiconductors and passive components are in stock now! Check the 2004 Catalogue components section for details, and check with stores for availability.

3 - 28V Wireless Auto Tester

- Buzz's, vibrates, and lights up when voltage is detected.
- Safe to use with ECU's, air bags, sensors, and transducers.

Cat. QP-2212 **$29.95**

LASCAR Switchmode Lab Power Supply

- 1.5-30VDC @ 1A.
- Voltage and current LCD display.
- Over voltage/current and short circuit protection.

Cat. HP-3095 **$199.00**

Blue 7 Segment LED Display

- Cool blue single digit.
- Common cathode.
- 50mCd typical.
- See website for data sheet.

Cat. ZD-1856 **$5.95**

Neon Spark Plug Tester

- A quick, simple way of testing for spark plug faults.
- Bright neon indication.

Cat. QP-2264 **$5.95**

DIY Coax Tool

- Cutter, stripper, crimper.
- Suits RG6, RG58, RG59.
- Intermittent use only.

Cat. TH-1875 **$19.95**

Screw Type F Connector Tool for RG6

- Make light work of twist on F connectors.
- Also separates shield from insulation.

Cat. TH-1876 **$9.95**

Stud/Metal/Volt Tester

- Locate wooden studs behind walls, plywood, and flooring up to 3/4" thick.
- Also detects voltage & metal.

Cat. QP-2282 **$29.95**

90 - 300VAC/DC Voltage Tester

- Bright neon light to indicate voltage presence.
- High quality insulated test probes.

Cat. QP-2240 **$3.95**

Water Displacement and Lube Spray

- Specially formulated for use with electronic and mechanical assemblies.
- 175g.

Cat. HA-1025 **$2.95**

4A 12VDC SLA Battery Charger

- Reverse & overload protection.
- Automatic switching to 300mA.

Was $99

Cat. HB-3528 **$79.00** SAVE $20

Heavy Duty 8A Car Battery Charger

- 4 stage LED charging indication.
- Heavy duty alligator clips.

Was $69.95 SAVE $10

Cat. HB-3522 **$59.95**

Dwell Tacho DMM

- RPM x 1, x 10.
- Dwell angle.
- 15A DC.
- Resistance.

Was $59.95 SAVE $10

Cat. QM-1440 **$49.95**

1000V 7 Piece Screwdriver Set

- GS and VDE tested and approved to 1000V.
- Soft rubber handles and insulation right to the tip.

Cat. TD-2022 **$19.95**

ARE YOU IN THE TRADE?

If you regularly purchase electrical or electronic goods for business purposes, you may qualify for a Trade Discount Card giving you 5% to 30% off! Speak to your store manager for details.

12VDC 60W Soldering Iron

- Cigarette lighter powered.
- High power to handle the big jobs.

Was $14.95

Cat. TS-1530 **$9.95** SAVE $5

Stainless Steel Side Cutters

- High quality blades, and comfortable handles.
- 115mm long.

Was $12.95

Cat. TH-1890 **$9.95** SAVE $3

Tool Magnetizer / Demagnetizer

- One slot for magnetizing, one for demagnetizing.
- 50 x 50 x 30mm.

Was $6.20

Cat. TD-2042 **$4.20** SAVE $2

Keyring Screwdriver Set

- Chrome Vanadium steel with forged handles.
- #2 Phillips, and 5mm slotted drivers.

Cat. TD-2012 **$2.95**

Car Battery and Alternator Tester

- Check battery state.
- Make sure alternator is charging properly.

Was $13.50

Cat. QP-2262 **$9.50** SAVE $4

www.jaycar.com.au

1800 022 888
Freecall For Orders

Jaycar Electronics

Dr Video Kit MkII

Supports Composite and S-Video Signals!

AN EVEN BETTER VIDEO STABILISER!
Ref: Silicon Chip June 2004.
Broadcasting information, time-code, and copy protection are just a few things that can cause interference with Plasma screens, projectors, and TVs. These devices, especially units with fast 100Hz display rates, can often flicker, poorly display, even not display the picture correctly. This project will filter the video from inferior signals to present a clearer, sharper display. Kit supplied with PCB, case, silk screened and punched panels, mains plugpack, and all electronic components.

NEW KIT

•Some SMD soldering required. Caution: During signal conditioning, this unit removes some forms of copyright protection. Video piracy is a crime, and Jaycar Electronics takes no responsibility for its potential for unlawful use.

Cat. KC-5390 $99.95

3V to 9VDC Converter Kit

•Ref: Silicon Chip March 2004.
•Use AA, C and D cells in place of 9V batteries.
•Includes PCB and electronic components.

NEW KIT

Cat. KC-5391 $14.95

Studio 350 - High Power Amplifier

•Ref: Silicon Chip Jan/Feb 2004.
•350WRMS @ 4 ohms
•200WRMS @ 8 ohms
•-125dB(A) signal to noise
•Includes PCB and electronic components
•Requires power supply and heatsink, see instore for a great deal on the components.

Cat. KC-5372 $175.00

Interior Light Delay Kit MkII

NEW KIT

•Ref: Silicon Chip June 2004.
•Light fade-out, simple wiring even for modern cars.
•Includes PCB, case and electronic components.

Cat. KC-5392 $18.95

Luxeon Star LED Driver Kit

NEW KIT

•Ref: Silicon Chip May 2004.
•Power 1, 3, and 5W LEDs from 12V.
•Includes PCB and electronic components.

Cat. KC-5389 $29.95

'Smart' Fuel Mixture Display Kit for Cars

•Ref: SC April 2004.
•10 LED indication with lean out alarm.
•Kit supplied with PCB and all electronic components.

Cat. KC-5374 $27.95

Emergency Brake Light Trigger Kit

•Ref: SC March 2004.
•Triggers brake lights with quick throttle lifts.
•Kit supplied with PCB and all electronic components.

Cat. KC-5373 $24.95

Digital Instrument Display Kit

•Ref: SC Aug/Sept 2003.
•Digital readout of an analogue sensor.
•Kit supplied with case, silk screened punched panel, PCB and all electronic components. SAVE $10
Was $59.95 •Ltd Qty

Cat. KC-5365 $49.95

50MHz Frequency Counter Kit

•Ref: Silicon Chip October 2003.
•High resolution with excellent accuracy.
•Kit supplied with case, silk screened and punched panel, PCB and all electronic components.

Cat. KC-5369 $69.95

In-Circuit Transistor Tester Kit

•Gives a quick Go / No Go indication.
•Works on all NPN / PNP bipolar transistors.
•Kit supplied with PCB and all electronic components.

Cat. KF-4000 $9.95

IR Multimedia Interface Kit for PCs

•Ref: Silicon Chip August 2003.
•Control MP3 and DVD software using remote controls.
•Kit supplied with PCB and all electronic components.

Cat. KC-5366 $39.95

Auto Power-Up Kit

•Ref: Silicon Chip July 2003.
•Automatically switch on peripheral devices when you power up the main device.
•Kit supplied with pre-cut case, silk screened panel, PCB and all electronic components.

Cat. KC-5363 $69.95

Sub Bass Processor Kit

•Ref: Electronics Australia September 1999.
•Enhance and filter bass signals for better sound quality.
•Kit supplied with PCB and all electronic components.

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(the spare parts list has these down as C1606-07, both being 220µF 16V as well).

Dead microwave oven

Michael, our microwave specialist (and all round good bloke he insists I inform you), was telling me about some of the problems he had been having with a couple of late-model Panasonic microwave ovens with inverter power supplies.

In particular, the circuit diagram errors are a problem. He showed me two circuit diagrams (ie, for NN-S453WF and NN-S553WF models) where the oven lamp and turntable motor would never work if connected as shown, since both sides of these components are connected to the mains Active via Power Relay A (RY2). And in another case, the QPQ schematic of the NN-S560WF series of ovens shows the mains actually being shorted out via the same Power Relay A (RY2)!

He also told me an interesting story about a Panasonic NN-S453WF which came in dead. The PC track from pins 1 & 3 of CN1 (mains input) to Power Relay A (RY2) had evaporated on the Digital Programmer Circuit (DPC). In addition, the PC fuse or "fuse pattern" (PF2) had blown, along with the track from Q223's collector to the relay coil.

There is a "Troubleshooting Guide" that comes with the service manual which says: "(1). Remove the jumper wire PF1; (2). Insert the removed jumper wire PF1 to PF2 pattern and solder it. If both PF1 and PF2 fuse patterns are open, replace the DPC".

Apart from the confusion when you look at the board as to which fuse pattern is which (he could only see PF2 and PF3 marked on this board), the answer invariably is to change the DPC. The circuit only shows three fuses and these fuses can also blow if the interlock safety switches are off-centre.

Michael tried repairing the DPC first by fitting the links where the track had blown. When he refitted the board into the oven, he found that the oven worked but the lamp didn't and the turntable motor kept on turning when the door was closed.

After replacing the lamp (probably the culprit for all this), he noticed that the new one stayed on all the time and so he decided to order and change the DPC (Part No: F603L5Q40QP). Both the oven lamp and turntable motor are controlled by Power Relay A (RY2) from Q223's collector (a surface-mounted transistor, DTC123JA), which in turn is driven from pin 9 {(E)P53} of microprocessor IC1 (MN101C589EL).

The new DPC looked perfect and there are no published installation instructions for initialising it or setting it up, so he just fitted it to find it made no difference! The lamp and motor were still on which was annoying.

After making absolutely certain that no mistakes had been made, he ordered yet another DPC. This time the board worked flawlessly and all the faults were cleared.

In the end, he found that Q223 was faulty on both the original board and the first replacement board.

Second-hand scopes

My luck turned for the better recently, as I had the good fortune to purchase some secondhand Tektronix oscilloscopes at give-away prices.

For example, I recently acquired a 465 (I won't tell you the price – you will weep), which is a 100MHz delay CRO, circa 1974. Unfortunately, this unit wasn't showing many signs of life when I first got it but with a bit of fiddling, I managed to get two stationary dots on the screen with the Beam Finder (and it wasn't in the X-Y mode)!

From this, it was obvious that the A and B horizontal timebase sweeps weren't working. When I removed the covers, the only clue I had was what looked like a "slightly-cooked" 33Ω resistor in the centre of the board underneath the CRO.

I had a copy of the manual for the Tektronix Model 466 but was dismayed to find that is quite different to the Model 465. So I got onto the Internet and found at least two sources for service manuals. One was **aa4df@aa4df.com**, an extremely helpful site in the United States where for only US$9 I could FTP download 198Mb of scanned manuals. The expensive part for me was the dial-up 56k connection and the time it took. The other site was Denis Cobley at **denis.cobley@newteksupport.com**, who can supply a scanned service manual on CD for AUD$25 from Tektronix right here in Sydney.

Denis was very helpful too and based on my description, suggested that the burnt resistor was in fact 22Ω (not 33Ω). He also said that the 1000µF electrolytic capacitor next to it may be

Items Covered This Month

- Akai CT-2167A TV set
- JVC AV32X25EVS TV set (MF II chassis)
- Panasonic NN-S453WF microwave oven
- Tektronix 465 oscilloscope
- Goldstar Models OS-7040A & OS-9040D oscilloscopes
- Panasonic TX-60P82A TV set (MX10 chassis)
- Panasonic TX-80VO3A TV set (MX12 chassis)

vertical deflection amplifier, as they can give trouble. These include C344, C331, C338, C326 and C401 but changing them made no difference. I then moved onto the resistors and replaced R421 as it was critical in supplying 12V to the jungle IC. This too made no difference, so I also tried heating and freezing the components but I continued to draw blanks.

Feeling increasingly desperate, I then went back through the notes and measurements I had made, looking for anything that might give a clue. I had already noticed that Vcc on pin 29 of the Jungle IC measured 10.54V whereas the circuit showed it as 12V. I tried shorting out the R421 I had already replaced but the rail only rose to 11.3V and it still made no difference to the picture.

Next, I connected an external power supply and wound it up to the full +12V but this also turned out to be a furphy. Pin 35 (feedback) measured 4.46V instead of 5.02 but changing C321, the only component on this pin, still made no difference.

What's more, pin 33 (vertical oscillator) measured 0.88V instead of 1.2V but I was now totally cynical about the voltages marked on the circuit diagram. For that reason, I initially didn't regard the difference as important, especially as waveform 18 was correct in shape, although a little low at 1.5V peak-to-peak instead of 2.2V. Still, it was my only real clue so far. I checked D305 as OK and then took a look at R331. This is marked 180kΩ on the circuit but is only 51kΩ in the set. I checked the parts list which also had it listed at 51kΩ.

Anyway, I removed it from the set and measured it. It was high, the meter showing a reading of about 70kΩ! I replaced it with a 56kΩ resistor (I didn't have a 51kΩ unit in stock) and the set immediately began vertically overscanning.

Resetting the height control finally restored everything to normal and put an end to my misery.

The pretentious JVC

A JVC AV32X25EVS TV with the pretentious name of "InteriArt" (employing an MF II chassis) came in under warranty, its owner complaining of a loud "popping" noise from the loudspeakers when the set was switched off.

It turned out that the set had been purchased back in 2002 and the fault had been present right from day one. It was only now that the customer had decided to bring it in. God knows why he had left it so long before complaining – perhaps it was because the warranty period was coming to an end?

Being blessed with an original service manual for a change, I could see that the audio amplifier was pretty complex, employing about 14 ICs and its own microprocessor. The subwoofer, which was the main "popping" source, was fed by power amplifier IC601 and controlled by a complex network of seven muting transistors and 11 diodes by five command rails: A_mute, audio_mute, Amp_mute, D_mute and centre (these are repeated for the left and right channel amplifiers and the audio output).

What ever happened to the KISS principle (Keep It Simple, Stupid)? This circuit seemed to be over engineered and unnecessarily complex.

I began by checking the ±9V, 8V, 10V, 24V and ±27V rails and these were all OK but I did find some major errors in the circuit diagram. This shows +27V coming out D954 and going all the way to pins 13, 14, 15 & 16 of connector CN004. However, on the next page, pins 13 & 14 are shown at -27V!

I then found a transistor (Q601) in the muting circuit whose function was described as "power on/off det". This seemed a good place to start making and comparing measurements, until I noticed that its emitter voltage was marked as +4.9V on the circuit while in practice it is fed via a forward-biased diode (D629) straight from a 9V IC regulator (IC605). This and many other mistakes in the circuit made it very difficult to troubleshoot this complex circuit.

What I did find were two electrolytic capacitors (C606 and C607) in series with Q601's emitter. Their job is to maintain a charge on the mute line until the audio amplifier has powered down, after the set is switched off. On the circuit diagram, they are marked as two 220µF 16V electrolytics but in the set itself, I found one 220µF capacitor and one 1µF capacitor. So which was correct – the set or the circuit diagram?

Because the service manual had other mistakes, I tried replacing these two capacitors with the same values as those already fitted. However, this made no difference, so I moved on and started testing other parts of the same circuit.

In the end, nothing I did was making any difference, so I went back to capacitors C606 and C607. What if it was the circuit that was correct and they both should be 220µF?

And that was it! The wrong value had been put in during manufacture and the service manual was correct

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SERVICEMAN'S LOG

Variety is the spice of life

I have rather a mixed bag this month, including several stories on TV sets, a couple of oscilloscopes and even a microwave oven. Servicing mightn't pay a fortune but at least the job is interesting.

I sold an Akai CT-2167A TV receiver in 1996 to Michael Selley. This was a 51cm stereo unit with teletext, made by Kong Wah in China and it had performed flawlessly for eight years. But now, it was paying me a return visit with what seemed like a trivial fault – ie, lack of height (letterbox).

Michael had phoned me in advance and I initially told him that this might be due to a transmission in 16:9 format from the TV station. However, he quickly informed me that it was now like this all the time.

We have an enormous number of people complain about under-scanned screens these days. Most feel that they have paid for a certain size screen and aspect ratio and therefore it should be fully scanned, regardless of the TV stations. The TV stations, on the other hand, couldn't give a monkey's, as long as you are watching their ads, so we get a lot of nuisance calls for this.

Michael's other problem was his remote control which was in near fatal condition, having survived (just) three young children (who like chocolate and Coca-Cola) and one dog. I eventually got it to go but only after stripping it down and cleaning out eight years of goo and corrosion. I also had to fix several dry joints and the battery springs before reassembling the case (which was missing large chunks of plastic).

MICHAEL'S *OTHER* PROBLEM WAS HIS REMOTE CONTROL, WHICH WAS IN NEAR **FATAL** CONDITION, HAVING (JUST) SURVIVED 3 CHILDREN & ONE DOGooo

Now for the TV itself. After removing the back, I began by checking all the main voltage rails: +106V, +25V, +15V, +7V, +5V, +180V, +22V and +12V. These were all as expected so I then set about checking the voltages around IC401, the AN5521 vertical deflection amplifier. Again, I could find nothing amiss, although access to this stage is quite difficult.

Next, I checked the voltage on the deflection yoke and this was 11.4V (half the Vcc to the output stage), as you would expect. I then measured the voltages on pins 29-35 of the AN5601k jungle IC (IC301) and again they were not far removed from the figures listed in the service manual.

However, you cannot put much store on the validity of the data in service manuals these days, as they are often full of errors and contradictions. This particular manual shows voltages on the block diagrams and the adjustments chart that contradict the circuit diagram in at least half a dozen cases. For example, it says on page 6 to adjust B+ to 106V ± 0.5V on TP405, which the circuit diagram clearly shows as +105V.

Out of ideas

By now, I was running out of ideas, so I adjusted the VR401 height control to its end stop to see what effect this had. The picture was now only 100mm from the top and bottom but I really didn't learn much from this other than that the height control was still working. I then got the oscilloscope out and checked waveforms 15 to 21 and these were all OK too.

This job was becoming more difficult by the minute. Despite all my measurements, I still had very little to go on. And from what little I did have, it was impossible to tell what was significant.

At this point, I decided to change all the electrolytic capacitors in the

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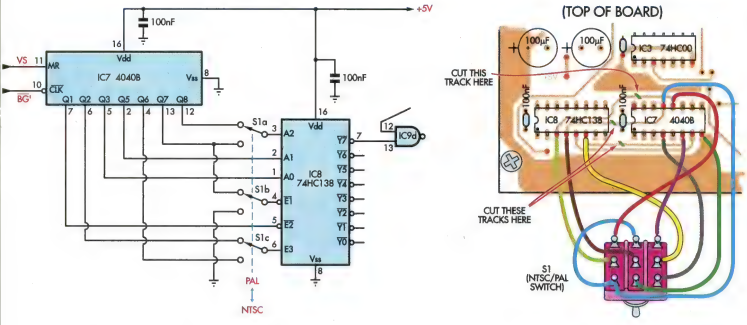
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Using Dr Video Mk2 to process NTSC video

As described in the June 2004 issue of SILICON CHIP, our improved Dr Video Mk2 stabiliser is only suitable for processing PAL standard video signals. However, if you'd like to be able to use it for processing NTSC standard signals as well, it can be modified fairly easily to allow this.

The modification involves adding a switch to change the decoding of line counter (IC7), so that the start of the gating pulses for Macrovision 'EOF' pulses is changed to suit the different number of lines in an NTSC video field (525/2 = 262.5, rather than 625/2 or 312.5 lines in PAL).

There are three inputs of decoder chip IC8 which need to be switched, as shown in the diagrams. This can be done fairly easily using a 3-pole double-throw miniature toggle switch, which can be mounted in the centre of the Dr Video Mk2 front panel. The existing tracks on the top of the PC board connecting to pins 3, 4 & 6 of IC8 need to be carefully cut as well, in the positions shown. This can be done using a small hobby knife.

The connections between the added switch and the PC board should be clear from the diagrams. Note that all of the wires connect directly to the pins of IC7 & IC8 on the top of the board. Make all of these soldered connections with an earthed low-power soldering iron and do the job quickly so you don't overheat the ICs.

When the modification is completed, added switch S1 is used to set the Dr Video Mk2 for processing either PAL or NTSC video as desired.

SILICON CHIP.

Room recorder

My wife was working on a doctoral dissertation and needed to do some field work involving personal interviews in various settings. What would be the best way, technically speaking, to record the interviews?

To pass a tape recorder or microphone back and forth seemed too awkward and clipping wired microphones to interviewees didn't make for a particularly informal atmosphere. Radio microphones seemed overly expensive, too. After some thought, I can up with the "Room Recorder", an add-on microphone preamplifier circuit for use with a tape recorder.

While I don't make any great claim to originality for the circuit, it has produced first class results over one year of interviews and might prove useful to anyone doing similar work.

The preamplifier was plugged into a Sony Cassette-Corder (any similar device will work) by means of a long, screened microphone cable and placed in a central location in a room or on a bench. The circuit will pick up every whisper, so background noise should be considered when choosing a location.

A 2-terminal electret microphone picks up the sound, which is then amplified by a TL071CN low-noise op amp. Note that the microphone's negative terminal is connected to its case.

Negative feedback is applied to

only goes to 150MHz (and this is a 200MHz CRO). However, I managed to also get this from Sphere Research Corporation in Canada – the freight cost more than the parts!

PS: point your web browser to **http://www.sphere.bc.ca/test/tekequiv.html** for a very useful Tektronix parts cross-reference data list.

Goldstar scopes

I also had to repair some ex-university Goldstar Oscilloscopes, models OS-7040A and OS-9040D. These are both 40MHz delayed sweep CROs.

The OS-7040A had intermittent "no display" and "no scan" symptoms and was fairly easy to fix, with all the trouble being dry joints on the power supply and EHT board. Reworking all the soldering on this board, including under the EHT screening cans, fixed all the problems.

The OS-9040D was a different story. There was no display on this unit but without a service manual, I was pretty well stuck. And so I went back to the Internet, where I tracked down a scanned copy of the "Operation Manual" which fortunately has a basic circuit in the back.

I started by checking the power supplies which provide +195V, +55V, +12V, ±5V, -12V and +32V. Next, I tried measuring the voltages to the tube. Unfortunately, I didn't know what to expect because there are very few voltages on the circuit.

To eliminate the tube, I swapped it with the unit in the OS-7040A and confirmed that there was EHT and high negative voltages on the cathode grid and focus pins. These were all OK but there was still no beam. I also established that both the timebases were oscillating correctly and giving waveforms to the deflection plates.

There are about 38 internal adjustment controls inside this CRO, some of which are not even marked on the circuit. At this stage, I was only interested in the ones affecting the display tube, which are the "CRT Bias" (VR617) and "HV Adj" (VR618). I marked their wiper positions and measured the voltage on them before adjusting them.

I was in luck – realigning these two controls restored the beam and after adjusting the focus (VR113) and astigmatism (VR616) controls, I got a beautifully sharp trace. Obviously, someone had been fiddling!

Finally, if anyone has the service manuals for any of these models, please contact me via SILICON CHIP.

Two more Panasonic TVs

I recently had two late model Panasonic TV sets come in with very similar fault themes.

The first was a 2001 Panasonic TX-60P82A (60cm picture tube) employing an MX10 chassis. The set was dead and it didn't take a mountain of intelligence to see that the flyback transformer (T501, ZTFN34001A) was cactus, just from looking at its condition.

However, having quoted for and "completed" the job, a secondary symptom which had been masked by the first appeared – the set would now cut out after five minutes.

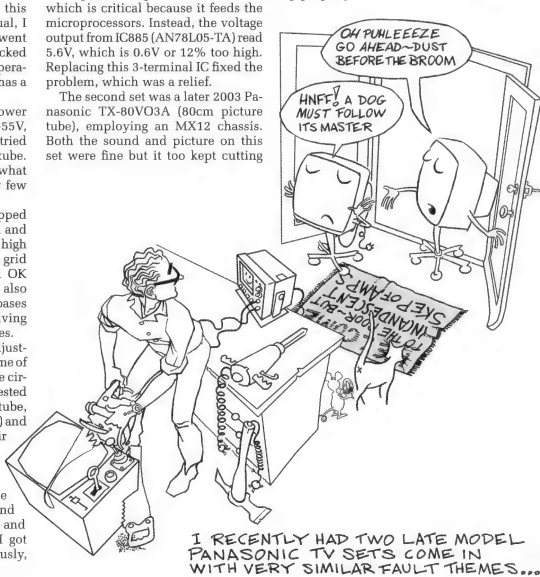
When in doubt, I start by measuring the voltage supply rails. Just about all were spot on except for the 5V on TPAS which is critical because it feeds the microprocessors. Instead, the voltage output from IC885 (AN78L05-TA) read 5.6V, which is 0.6V or 12% too high. Replacing this 3-terminal IC fixed the problem, which was a relief.

The second set was a later 2003 Panasonic TX-80VO3A (80cm picture tube), employing an MX12 chassis. Both the sound and picture on this set were fine but it too kept cutting out after 3-4 minutes, with the picture and LED pulsating.

All eight voltage rails checked out OK but the power control IC (IC801) was getting hot. And, as I quickly discovered, the symptoms became worse during testing. The pulsating frequency began to change and then the set died completely after momentarily displaying a white line across the screen.

I replaced the vertical output IC (IC451, TDA8177) which improved the symptoms a little but it still kept turning off after 3-4 minutes and IC801 was still getting very hot. In the end, more by luck than good judgement, I spotted a small crack on T801, the chopper transformer ferrite former. This was undoubtedly causing the power supply to work harder and therefore get hotter.

A new transformer fixed everything up properly. **SC**



by the usual method of shorting the two sides by means of a jumper".

I tried removing Q1024 as suggested but it made no difference. However, I couldn't comprehend the latter piece of advice and was too chicken to try it – there just wasn't enough detail.

So now I was stuck. With old Tektronix gear, you don't just rush out and buy parts and fit them on a hunch as they can cost and an arm *and* a leg. However, my money was on U870 as being the most likely culprit. The part no: is 155-0049-01 and I found out it costs $A160 + GST + freight from a company in Victoria.

Fortunately, I got a lucky break. I managed to get access to a Model 475 oscilloscope, which uses the identical IC as U600. And swapping the two ICs over transposed the faults from one oscilloscope to another.

Then, unbelievably, I had a second break. I managed to obtain a brand new IC for only $US25 from Sphere Research Corporation in Canada, via the Internet. Now all I need is to get the Option 05 TV Sync Separator retrofit kit (as fitted in the 465B), which is necessary for TV and video work. Does anyone know where to get one?

Another problem

I had an additional small problem with the Ch2(Y) vertical preamp. The calibration knob was set in the "UNCAL" position and wouldn't switch to "CAL". The reason was simple enough. The coupling shaft was not engaging the shaft of the control and was slipping.

The difficult part was access to tighten the allen key grub screws. I eventually used a very long 0.05-inch allen key to reach and tighten the grub screws, only to have the aluminium collar break apart and fall into the equipment. *Quelle horreur!*

Well, what to do? There was Buckley's chance of getting a new one. However, this control is not that important as long as I could get the switch back to the "off" position.

Well, I tried all sorts of special tools to coax this rotary switch back into the "off" position. I got it so close but extra force was needed to move the switch which I just couldn't supply.

In the end, I gave up and decided to just glue the plastic coupler left onto the shaft so that the knob wouldn't pull out of the mechanism. To do this, I applied a large drop of superglue onto a very thin long screwdriver and very gingerly inserted it between the PC boards until I got some of the glue onto the shaft. I then pushed the knob and its long shaft into position, so that the plastic coupler went over the control shaft and glue. Finally, I wiggled the knob back and forth to spread the glue around.

As I was doing this, the superglue suddenly set hard (as it does) and the knob, shaft and control all engaged and I managed to switch it off easily. Since then, this control works well but I am reluctant to use it in case it breaks again.

I also had a problem on a Tektronix 475 with the Ch2(Y) position centring control. The beam was at the extreme top of the picture with the control turned completely anticlockwise.

The circuit shows this control as varying the control voltage from +8V to -8V. This is applied to the junction of Q272, Q278 and Q282, Q288 in the third cascade amplifier.

Well, I could get it to go positive but I couldn't get it to go very negative at the junction of Q272 and Q278. Remembering that everything is socketed, I decided to switch the transistors one at a time with those of the Ch1(X) vertical preamplifier. And when I swapped Q278 with Q178 I transposed the problem to the other beam.

Q278 turned out to be open circuit and fitting a BC558B fixed the problem in the short term. The only thing is that Q278 is a 2N4261 PNP Si transistor (Part No. 151-0434-00 or 151-0202-00) which has a frequency response in excess of 2GHz, whereas a BC558

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the culprit and that I should start my investigations with the sweep logic IC.

Different ball game

I have to say that repairing oscilloscopes is a different ball game to fixing TVs, with a complete set of new buzz words to learn!

Armed with the 300-odd page service manual, I established that the resistor was R1220 and mine measured 27Ω instead of 22.1Ω. The capacitor was C1220 and is an axial type rated at 10V. It measured perfectly OK but there was no -8V being fed to it. In the end, I replaced it anyway – when I finally managed to track down a 1000µF axial capacitor.

I eventually found that the cause of the missing -8V rail (and +5V rail as well) was due to a faulty CR1561 bridge rectifier. Initially, I replaced this with four 1N5408 diodes which are rated at 3A each but they ran warm. The original 15-0488-00 bridge is rated at 200V 1.4A. I eventually managed to get and fit a 6A bridge (KBU602) for just $1.55 from WES Components.

This didn't completely solve the problems, however. Both the X and Y amplifiers were now working and I could centre the traces but there was still no horizontal sweep.

I had been told that no specialised parts were available for this now 30-year old CRO, so all I could do was hope that nothing critical was at fault. Anyway, the U870 Sweep Control IC seemed like a good place to start my investigations. A good tip Denis gave me was to start by reading the concise circuit description in the manual before doing anything. This I did and I prayed that it wasn't the IC itself, as I would have Buckley's chance of getting a new one.

Having read the manual, I started by measuring the DC voltages around the IC before checking the waveforms with another CRO. The 465 manual had very few waveforms in it but the 466 – which has its similarities – did have waveforms printed on the circuits.

I soon discovered that the only waveform was on pin 1 of the IC (TD in Auto Sense Input) and around transistors Q862 and Q864. All waveforms fizzled out after diode CR863. I had incorrect voltages on pin 6 (Auto gate timing), pin 8 (holdoff output) and pin 14 (sweep reset).

The sawtooth sweep generator based on Q1030 & Q1036 (Miller integrator) and Q1012 & Q1014 (multivibrator) wasn't oscillating. However, there wasn't much point in swapping transistors and FETs from the A sweep circuit to the B sweep, as that wasn't working either.

A few quick voltage checks showed that Q1024's collector was incorrect at -0.42V instead of -1.7V. This made me suspect the time/div switch (S1150), especially as you could momentarily see a fully-scanned waveform in detail by rotating it quickly. I also suspected Q1030 (an N-channel FET) but swapping it with Q1090 made no difference.

The only other inconsistencies I found were incorrect collector voltages on Q854 and Q804. However, according to an article on servicing the 465 portable oscilloscope in TEKSCOPE "... the sweep circuit contains several feedback circuits and is difficult to troubleshoot unless you break the feedback loop. A convenient means of doing this is to pull the Disconnect Amplifier (Q1024) out of its socket. This causes one sweep to be generated and often provides a rapid clue as to what portion of the circuit is in trouble. The horizontal amplifier is push pull and can be checked

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PICAXE-based cable tester

This cable tester can test loose cables (where both ends can be brought together) and installed cables (where the cable ends are remote from each other) with up to three conductors.

For all loose cables and for installed cables where at least two conductors are working, it tells you exactly which pins of the cable are connected to each other.

The tester consists of two parts: (1) the local unit, which contains the PICAXE-08 and power supply; and (2) the remote unit, which is passive. Both units have one LED for each pin.

The tester indicates which pins are connected together by flashing the associated LEDs. The number of flashes is equal to the lowest numbered local pin of the group. For example, if local pins 2 & 3 and remote pins 1 & 3 are all connected together, the LEDs associated with those pins will all repeatedly flash twice.

The LEDs associated with any remote pins that are not connected to a local pin will remain off. Nevertheless, there may be connections between one or more of the remote pins. These can be found by swapping the local and remote units of the tester to the opposite ends of the cable.

The return link is used when a loose cable is being tested and both parts of the tester are close enough to connect together. Using this method, the tester will give correct indications for cables with any number of working conductors. Note that without the return link, no remote LEDs will light unless there are at least two separate conductors connecting the local and remote ends of the cable (it doesn't matter which pins these connect).

As shown on the circuit, each local pin of the cable is connected to an I/O pin of the PICAXE-08. The PICAXE-08 program pulses the pins to flash the associated LEDs.

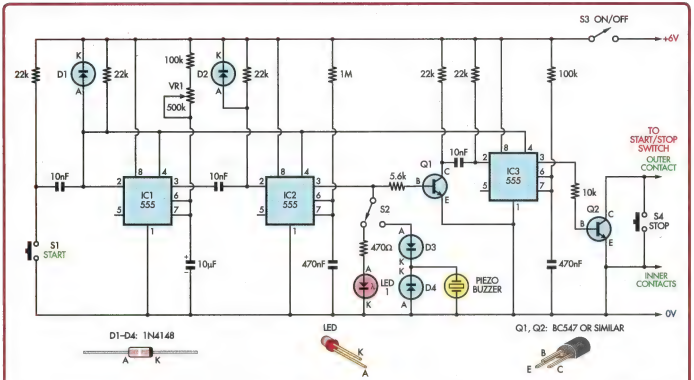
The program considers each local pin in sequence. If a pin has already been pulsed in the current round it is skipped, otherwise it is pulsed. However, the program cannot pulse each pin individually, because it could be connected to other local pins. This would drag its voltage to an indeterminate value. Instead, the program first identifies all other local pins that are connected to that pin (call them the "P" pins) and pulses them low in unison. The remaining pins ("non-P" pins) are held high during the pulse.

Operation of the remote LEDs is as follows: with the return link in place, +4.5V is applied to the anodes of the remote LEDs. If the return link is absent, diodes D1-D3 provide power to the LEDs instead, assuming at least one of the remote pins is connected to a local "non-P" pin. Each of the remote pins that connect to local "P" pins will be low and therefore the associated LED will light.

Following each pulse, the program sets all pins to be high outputs, turning all LEDs off. The best way to avoid being overwhelmed by all the flashing is to focus on one LED at a time and shield the others from sight.

It should be possible to expand the tester to deal with more lines by using a PIC16F84 which has 13 I/O pins, each of which can sink or source up to 25mA. Because each pin must potentially sink current for every LED, the LED current should be set to about 1mA. This can be

```
'-------------------------------------------------------------------
' PICAXE-08 Cable Tester
'-------------------------------------------------------------------
'
' Hardware:
'
' PIN1 (leg 6) is local pin 1
' PIN2 (leg 5) is local pin 2
' PIN4 (leg 3) is local pin 3
'-------------------------------------------------------------------

symbol zero             = %00000000
symbol local_pins       = 3                 'number of local pins to test
symbol P                = b1                'current pin (range: 1 to local_pins)
symbol count            = b2                'count of pulses so far on the P pins
                                            '(range: 1 to P)
symbol P_bit_low        = b3                'bitmap with pin P low, other pins high
symbol P_bit_high       = b4                'bitmap with pin P high, other pins low
symbol P_pins           = b5                'bitmap: set of local pins connected to pin P
symbol yet_to_test      = b6                'bitmap: set of pins yet to test
symbol test_bit         = b7                'result of testing if P is in yet_to_test

symbol dummy            = %00000000
symbol local1_high      = %00000010
symbol local2_high      = %00000100
symbol local3_high      = %00010000

symbol all_high = %00010110

symbol local1_low       = %00010100
symbol local2_low       = %00010010
symbol local3_low       = %00000110

symbol all_low          = %00000000

loop:
  let yet_to_test = all_high                'initially we are yet to test all pins.

  for P = 1 to local_pins

' Skip pin P if already pulsed (ie, if it is not in yet_to_test)
' Set P_bit_high to a byte with the pin P bit high and all other pins low.
' The first entry in the table is a dummy because P is never zero.
' The second entry is for local pin 1, the third is for local pin 2,
' and so on.

  lookup P, (dummy, local1_high, local2_high, local3_high), P_bit_high
```



An accurate reaction timer

Add a cheap stopwatch to this circuit to produce an accurate reaction timer. The circuit is wired in parallel with the start/stop button in the watch via a 2.5mm socket, which fits snugly in one corner of the casing.

The person conducting the test (the "tester") resets the stopwatch and turns on the reaction timer's power switch (S3). The person being tested (the "subject") places his or her fingers near the "STOP" push-button switch (S4). Next, the tester covertly sets a delay time with VR1 and selects either the LED or buzzer alarm via S2.

To initiate the sequence, the tester then presses the "START" switch (S1). This triggers 555 timer IC1, which is wired as a monostable. Its output (pin 3) goes high for 2-12 seconds as determined by the setting of VR1. At the end of this delay pin 3 goes low and triggers IC2, another 555 timer in monostable mode.

The output from IC2 (pin 3) activates the alarm (buzzer or LED) for about 0.5s. After inversion by Q1, it also triggers IC3, another 555 monostable. The positive pulse from IC3 turns on Q2, briefly closing the start/stop switch circuit in the watch.

The watch starts to count up. After a short period, the subject reacts to the alarm and pushes the "STOP" button (S4), freezing the stopwatch. The reaction time can then be read off with 1/100th of a second accuracy.

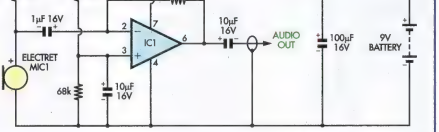
Comparative reaction times could be measured when a subject is: rested or tired, silent or talking, before or after a night out, using a mobile phone, etc. For motoring realism, rig up dummy accelerator and brake pedals, with the brake switch making the stop contact. Or take it to your club and test people as they enter and after they've been "steadying their nerves" at the bar.

A. J. Lowe,
Bardon, Qld. ($40)

the inverting input through a 10kΩ resistor. Increasing the value of this resistor will increase sensitivity, and vice versa. For ease of use and quietness of operation, the circuit is powered from a 9V battery. The power switch is mounted on the case.

The circuit draws about 2mA and would therefore give about 10 days continuous service from a 9V alkaline battery.

Thomas Scarborough,
South Africa. ($25)



This simple microphone preamp circuit is based on a single low-cost IC.

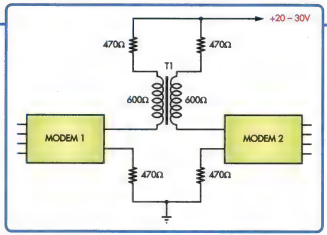
How to connect two PCs using modems

Have you ever connected two PCs together via modems using a twisted pair cable and nothing happened? That's because the modems are expecting a phone line with all the signals and voltages supplied by the local telephone exchange.

This circuit simulates the DC power and signal isolation but not the "dial tone" or the "ring signal". It suffices to connect two PCs together to communicate and exchange files using HyperTerminal.

The circuit is self-explanatory and needs only one power supply for both modem lines. Although 50V DC is the usual exchange line voltage, this circuit should operate down to 20V. A 600Ω line transformer (eg. Jaycar cat. MM-1900) provides signal isolation, while the resistors provide current limiting and keep the lines as balanced as possible.

When using this set-up with HyperTerminal, you should not select a Windows modem driver in the "Connect To" dialog. Instead, connect directly to the relevant COM port. Next, verify that the modems are working by sending information commands such as "ATI1" or "ATI3". If you don't get a response using these commands, try resetting the modem(s) using the "AT&Z" command.



Assuming you do get a response, set one in originate mode using the "ATD" command and the other in answer mode with the "ATA" command. If all is well, you should now be able to type in one terminal window and see the results echoed in the second PC's terminal window. To return to control mode, type "+++".

The advantage of using modems instead of a serial cable between COM ports is that the two PCs can be kilometres apart instead of a few metres. For example, you could connect the house PC to the workshop PC on the other side of the farm.

Filippo Quartararo,
Tranmere, Tas. ($25)

PICAXE code stops false triggering

Does your homebrew PICAXE project behave abnormally when you use long leads to connect to sensors and switches? If so, it could be due to electromagnetic radiation from the mains that occurs during appliance switching. This can induce large voltages across the sensor leads – large enough to false-trigger the high-impedance port pins.

Newcomers to the PICAXE micro may not be aware of one possible solution to this problem, which can be summarised as follows:

Assume that a program is waiting for a particular input pin to go high before performing a particular function. When that pin does go high, a short delay is executed and the pin state is read again. If it is still high, then the function is executed. If not, the original high is ignored; it is assumed to be "noise induced".

Below is a condensed section of code that demonstrates the method. In this case, an IR sensor and switch are wired up with long leads to PICAXE port pins 3 & 4.

Initially, the program determines day from night by reading an LDR connected to the ADC input. Assuming the result is night, pins 0 & 2 are driven low and the program reads the inputs on pins 3 & 4.

```
'----------------------------------
' Example code to reject noise-induced
' state changes on PICAXE port input pins.
'----------------------------------
main:
  readadc 1,b0
  if b0>50 then daylight
  if b0<=50 then night

night:
  low 2
  low 0
  if pin3 = 1 then both
  if pin4 = 1 then light
goto main

both:
  pause 200                 'wait awhile
  if pin3=0 then main       'ignore pin change
                            'if not still high
  high 2
  high 0
  goto main

light:
  pause 200                 'wait awhile
  if pin4=0 then main       'ignore pin change
                            'if not still high
  high 2
  goto main
```

If the sensor tied to pin 3 reads high, the program branches to label both. After a pause of 200ms, pin 3 is examined again. If it is still high, the program continues, otherwise no action is taken and the program simply loops back. The same method is used to de-glitch pin 4. Depending on the application, you may need to shorten the delay time so that genuine pin changes are not ignored.

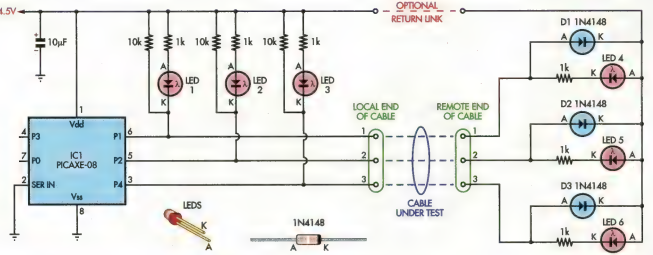
Paul Walsh,
Montmorency, Qld. ($20)

Stepper motor controller

P. van der Veiden is this month's winner of the Peak Atlas LCR Meter.

This circuit improves on a typical PWM (pulse width modulated) stepper motor driver by reducing the drive current to the motors when they're not in motion. The result is a significant reduction in motor heat and driver dissipation.

Stepper motor controllers, such as the L297 in this design, utilise PWM chopper circuits to control motor current. When there is no activity on any axis, considerable heat is generated



achieved by replacing the 1kΩ resistors with 3.3kΩ resistors. It would be advisable to use high-brightness LEDs at this current level.

Andrew Partridge, Kuranda, Qld. ($45)

```
let test_bit = P_bit_high & yet_to_test      'test_bit is non-zero if
                                             'P in yet_to_test
if test_bit = 0 then skip_pin

' Set P_bit_low to a byte with the pin P bit low and all other pins high.
' The first entry in the table is a dummy because P is never zero.
' The second entry is for local pin 1, the third is for local pin 2,
' and so on.

lookup P,(dummy, local1_low, local2_low, local3_low), P_bit_low

' Find the set of pins connected to pin P.
' Do this by taking pin P low and leaving all others as inputs.
' Any inputs that then read low must be connected to pin P, so they
' are removed from the yet_to_test set.

let dirs = P_bit_high                        'pin P is output, others are inputs
let pins = P_bit_low                         'take pin P low
let P_pins = pins                            'P_pins is the set of pins that read as low

let yet_to_test = yet_to_test & P_pins       'do not test the other
                                             'pins that went low

let dirs = all_high                          'set all pins to outputs

' Pulse all P_pins P times.

for count = 1 to P
let pins = P_pins                            'take the group of connected pins low
pause 200                                    '  for 200ms

let pins = all_high                          'take all pins high
pause 200                                    '  for 200ms
next count

' If all the local pins are connected together, pause a while
' longer so the end of the flashing sequence can be distinguished.

if P_pins <> all_low then no_pause
pause 800
no_pause:

skip_pin:
next P
goto loop

end
```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by the holding current of the motor. Switching the motor off for the duration of inactivity is not the answer as it is quite possible to lose position under these circumstances. The solution suggested here simply involves reducing drive current a short time after each step command.

The L297 senses peak motor current via two 0.47Ω resistors connected between pins 13 & 14 and ground. The peak level is regulated according to the reference voltage on pin 15, which is instrumental to this design.

Normally, a fixed reference voltage would be used here to match the current rating of the motor. However, this design can apply two different reference voltages with the aid of a MOSFET switch and a little extra circuitry, as follows:

During normal operation, pulses on the "STEP" input command motor movement via the L297s "CLK" pin. In this design, the "STEP" input is also used to trigger a 555 timer (IC3). The 555 is configured as a monostable, with its period determined by the 10MΩ resistor and 220nF capacitor connected to pins 6 & 7.

The output pulse from the 555 is inverted by transistor Q1 and applied to the gate of a MOSFET switch (Q2). A VN0106 type MOSFET is used here but just about any device with a low drain-source "on" resistance would be suitable.

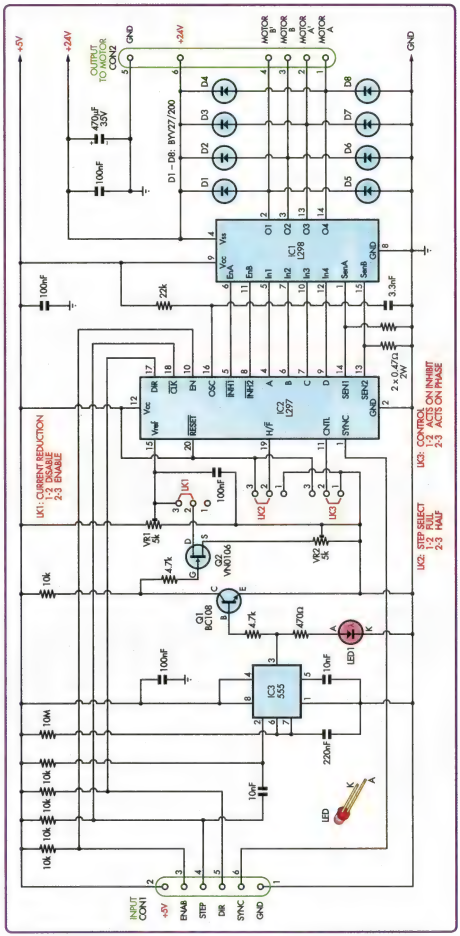
In operation, the MOSFET gate is pulled down near ground potential for the duration of the monostable pulse width (about 2s), holding it off. In this state, the reference voltage to the L297 is determined solely by trimpot VR1.

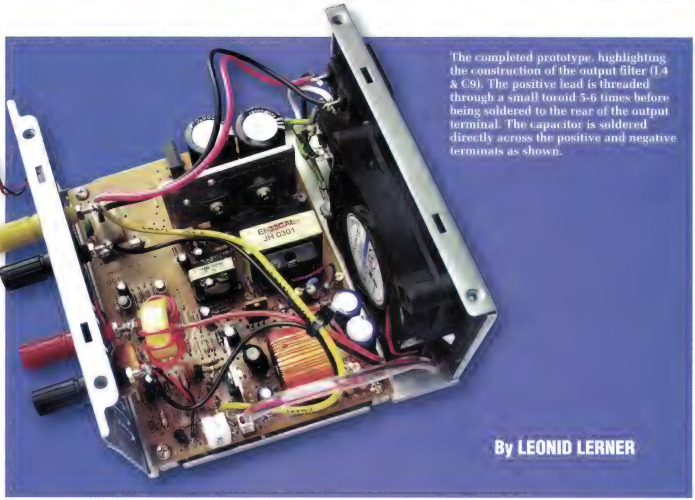
When the monostable expires, transistor Q1 switches off and the gate of Q2 is pulled up to +5V via 4.7kΩ & 10kΩ resistors. This switches Q2 on, connecting a second trimpot (VR2) in parallel with the first.

The end result is two adjustable reference voltages, generating two different motor currents. With no step pulses on the input, the reference voltage is reduced by the second trimpot, thereby reducing motor current.

A single axis prototype was build using this circuit with excellent results. There are no missing steps, the heatsink for the L298 full-bridge driver stays a lot cooler and there is much less heat in the motors when stationary.

Peter van der Velden,
Flagstaff Hill, SA.





The completed prototype, highlighting the construction of the output filter (L4 & C9). The positive lead is threaded through a small toroid 5-6 times before being soldered to the rear of the output terminal. The capacitor is soldered directly across the positive and negative terminals as shown.

By LEONID LERNER

A regulated 125W HV supply for valve amplifiers

Looking for a low-cost high-voltage (HV) supply to run valve circuitry? Here's how to modify a PC power supply to produce a 700V or 400V HV rail.

VALVE CIRCUITS are not yet dead. While transistors are undoubtedly superior in most applications, the valve still offers several unique advantages. This applies first and foremost to its use in power circuits.

There exists a substantial body of opinion that valves outperform transistors in high-quality audio amplifiers, especially in the power output stages. The seriousness of these claims is reflected in the fact that some very reputable manufacturers offer valve amplifiers at the top end of their audio range. For the home constructor, reasonable-quality valve audio amplifiers can be made for a modest outlay using designs available freely on the Internet. These amplifiers are generally based on an EL34 or KT88 valve pair in the output stage, with both valves being readily available in Australia.

Another common application for valves is in the output stages of RF power amplifiers. They will operate satisfactorily at frequencies of up to about 30MHz, delivering up to 50W per valve. Their main advantage over RF power transistors, apart from being somewhat cheaper, is that they are much more tolerant of fault conditions.

When tuning a new power amplifier design, parasitic oscillations are often encountered which can easily destroy expensive RF power transistors. The valve, however, will live to see another day. Valves are therefore much more suitable for experimentation in new designs.

Although valves are readily obtainable, one of the main problems in

their exploitation is the lack of suitable power supply transformers. Both the EL34 and KT88 are rated at a maximum plate voltage of 800V, with supply voltages in the order of 500-600V needed to extract maximum power and linearity. However, the only readily available high-voltage power transformers are isolating transformers, which deliver 240V, and magnetron transformers from microwave ovens, which deliver 1500V or more.

Clearly, both of these are unsuitable for our application.

The easiest way around this is to modify the switchmode power supply of a personal computer (PC), as explored in a previous issue of SILICON CHIP (October 2003). The older AT power supplies are readily available and have now become a surplus item. They are designed to produce about 200-300W, which is in the right ballpark for our application. For little cost, they include a ready-made PC board and almost all of the components we need for a HV switching power supply.

Moreover, due to its high operating frequency, the switchmode power supply offers much better regulation and far less ripple than can be obtained from a traditional valve power supply based on 50Hz AC rectification and smoothing.

Basic considerations

At first, it would appear that getting a PC power supply circuit to operate at high voltages involves just a few changes to the procedure outlined in the previous SILICON CHIP article. In particular, the number of power transformer secondary turns would have to be increased and all diodes, capacitors, and inductors would have to be replaced with high-voltage types.

The resistive ladder used to sense output voltage would also have to be changed. However, after a few trials, I found that the switching power transistors did not last long and it soon became clear that getting the circuit to

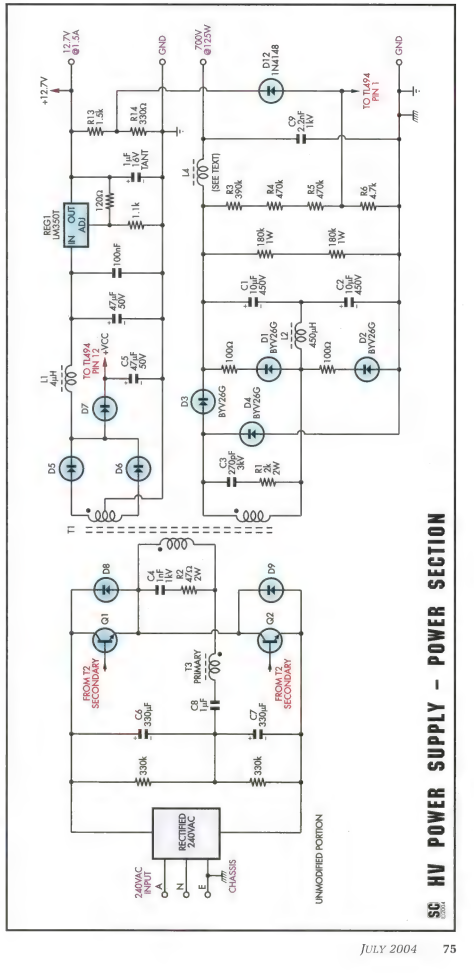


Fig.1: the power section of the modified high-voltage supply. Using the values shown, the output is a well-regulated 700V, suitable for driving two power valves. You can also build a 400V version by winding T1 & L2 accordingly and selecting alternate values for capacitors C1 & C2 and the R3-R5 divider string (see text).

SC HV POWER SUPPLY – POWER SECTION

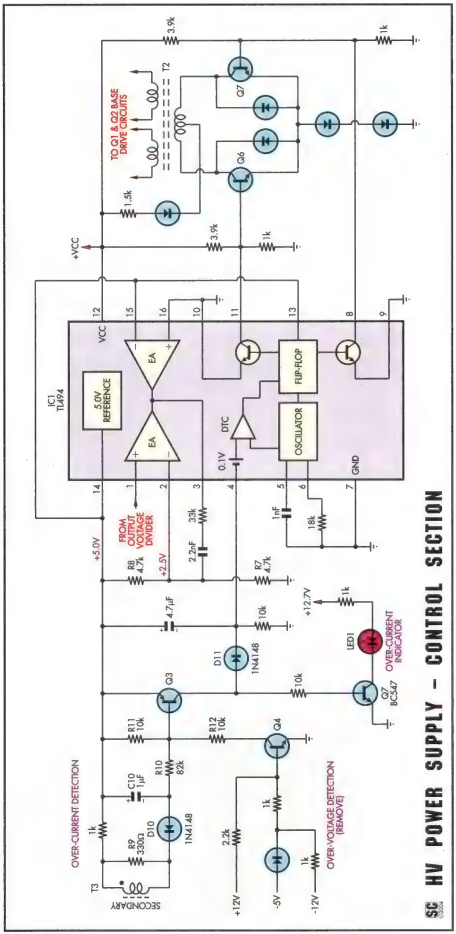


Fig.2: the schematic of a typical control section based on the TL494 PWM controller. The only changes needed here are the removal of the over-voltage detection circuitry and the addition of an over-current indicator, based on Q7 and an LED.

operate at 700V would entail a more substantial redesign.

The main problem is that the volts-per-turn ratio used in the secondary winding of a standard PC ferrite-cored transformer (operating in step-down mode) is about one turn per volt output. This means that 700 secondary turns would be required for an output of 700V.

And that's where we quickly run into problems. The power handling capacity of a coil, without considering insulation, is almost directly proportional to its volume. For example, if we wish to double the output voltage produced by a transformer, we have to double the number of secondary turns, and thus the coil length. The resistance of the coil will also approximately double.

However, if the coil is to deliver the same power, the output current is halved so that the coil's "ohmic" (I^2R) losses are halved. To compensate for this, we can halve the wire's cross-sectional area so that the overall volume occupied by the coil is unchanged. Unfortunately, a multi-layered coil operating at high voltages and frequencies requires insulation whose thickness increases roughly proportionally to the voltage. As a result, our coil does not follow the volume law.

In fact, it is almost impossible to fit a 700-turn winding with adequate insulation into the space available around the core of a standard transformer.

The reason for the large number of secondary turns is that the original PC supply uses a full-wave centre-tapped rectifier configuration, which requires twice the number of turns of a full-wave non-centre-tapped configuration. However, even a non-centre-tapped configuration causes problems.

For a start, it is difficult to fit even 350 turns in the space available around the core. Also, the bridge configuration has no "cool" end of the secondary winding, with both ends alternatively switched between ground and maximum voltage. This means that heavy-duty insulation needs to be used

between the primary and secondary windings.

Another problem is related to the mode in which the PC power supply operates. It relies on varying the duty cycle of the rectified mains pulses applied to the transformer to control the output voltage. This means that the secondary rectifier and filter network must be designed to supply an output voltage dependent on that duty cycle. A simple capacitive filtering network is unsuitable, as it would charge to the peak secondary voltage regardless of duty cycle.

The way this dependence is normally introduced is to place an inductor of appropriate value between the rectifying diode and the capacitor, forming an LC filter. However, combining an LC filter with a bridge rectifier does not clamp the secondary voltage, allowing large spikes to appear across the primary during transient conditions.

Voltage doubler solution

The schematic diagram in Fig.1 shows a solution to these problems. It's based on a voltage doubler circuit fed by a relatively low secondary voltage, making the secondary winding easy to fit around the core. A filter inductor (L2) introduces the duty cycle dependence necessary for pulse-width modulation (PWM), while diodes D1 & D2 clamp the secondary voltage, thereby limiting voltage spikes across the primary.

There is sufficient space left around the former for a second 12.6V/2A secondary to feed the filaments of two power valves. This winding is also used to power the switchmode controller circuitry and the cooling fan.

The price we pay for going to the voltage doubler configuration is reduced power handling. The load current of the centre-tapped configuration has a large DC component and only about 20% ripple, whereas in the voltage doubler configuration current must drop to zero at some point in the cycle. This means that the average current is at best half the maximum current. And since the latter is limited by the saturation current rating of the transformer, the HV circuit can deliver just over 60% of the power of the original supply.

This does not apply to the 12.6V centre-tapped secondary, however. So, from an original power rating of 200W, 125W is now available for the HV supply. Alternatively, the unit can supply 20W for the filament supply and about 105W for the HV supply. This is more than sufficient to operate two power valves.

The circuit is capable of excellent performance. It maintains full regulation at up to 125W, with ripple at 2V peak-to-peak, or 0.3% at full power. This is quite acceptable, as most of the ripple is at twice the switching frequency (60kHz) and so is inaudible.

The 100Hz hum component is only 0.08%, which shows the excellent regulation of the TL494, since the rectified mains source contains 13% of 100Hz ripple at full power. Over-current protection is retained, with a LED added to indicate when it is active.

Circuit operation

The schematic of the power section of the HV supply is shown in Fig.1. The mains input and associated switching transistor circuitry remain unchanged, as indicated by the shaded portion of the circuit.

Typical control circuitry based on a TL494 PWM controller is shown in Fig.2. There is quite a bit of variation in the control circuitry between different manufacturers, so your circuit might differ somewhat. This is especially true if the over-voltage and over-current protection in your supply is based on the LM339 comparator rather than on discrete transistors, as shown. Fortunately, there are few modifications to this part of the circuit.

Operation is quite straightforward, with the design based on a conventional half-bridge "forward converter" topology. The 240VAC mains is first rectified and then filtered by the capacitive divider C6 & C7 to provide two supplies at ±170V DC. This is switched alternately through the ferrite transformer by power transistors Q1 and Q2.

A 1µF capacitor connected in series with the transformer primary limits the current by forming an 8Ω load with inductor L2. This provides some protection in case of a shorted secondary, which effectively occurs at startup before C1 & C2 are charged as well as during fault conditions. Transformer T3 is used to sense the magnitude of the primary current for over-current protection.

The secondary winding develops a voltage of 502V using the specified turns ratio. For 400V designs, the secondary voltage reduces to 319V. This is rectified in the voltage doubler (D3 & D4) and smoothed by an LC filter (L2, C1 & C2).

During the "on" period, energy coupled to the secondary winding finds a current path through L2 and into the load and output filter capacitors. During the "off" period, the energy stored in L2 is discharged into the load.

The inductance of L2 is chosen so that current continues to flow for most of the "off" period at full load. You can see this effect in the SPICE simulation (Fig.3). As previously described, the use of an LC filter ensures that the output voltage depends on the duty cycle, as required for PWM control.

Diodes D3 & D4 have to withstand a reverse voltage of about 900V during the transistor "on" period, as well as

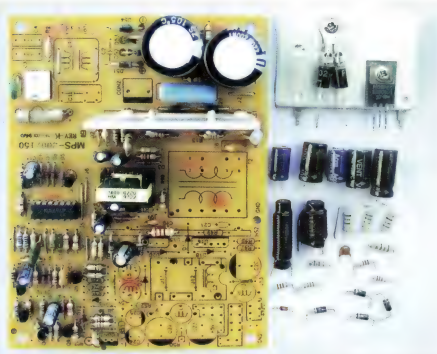
WARNING!

This is NOT a project for the inexperienced. Do not even think of opening the case of a PC switchmode power supply (SMPS) unless you have experience with the design or servicing of such devices or related high-voltage equipment.

Some of the SMPS circuitry is at full mains potential. In addition, the high-voltage DC output from this supply could easily kill you. Beware of any residual charge on the mains and output capacitors, even if turned off for some time.

The metal case and ground (0V) outputs of all PC power supplies are connected to mains earth. You should verify that these connections are in place after completing any modifications; under no circumstances should the output be floated!

DO NOT attempt to modify a SMPS unless you are fully competent and confident to do so.



The first step is to remove all of the low-voltage components on the secondary side in preparation for the HV rebuild.

some voltage spikes passed from the primary to the secondary by interwinding capacitance. Note that these spikes are generated during the "off" period by primary leakage inductance - they do not transform to the secondary inductively. Hence, the BYV26G fast avalanche diode with a peak reverse voltage of 1400V was chosen for the job. These are available locally from RS Components (Cat. 216-9397).

Diodes D1 & D2 provide a low impedance return path for inductor (L2) current during the switch-off period. They also combine in the D2-C2-C1-D3 and D4-C2-C1-D1 circuits to clamp the secondary voltage to $\pm V_{OUT}$.

One of the advantages of this clamping method is that it passes much of the energy stored in the core of T1 to the load. This energy would otherwise recirculate through the primary side protection diodes (D8 & D9), as well as dissipate in a more aggressive clamp or snubber network with higher losses.

At power up, the clamp forms a short circuit across the secondary until C1 & C2 are charged, so 100Ω resistors have been inserted to limit the maximum current. The clamp is important in reducing the inductive kick of the primary winding (as opposed to the primary leakage inductance whose kick can not be avoided). The effect of the secondary clamping can be seen as a plateau during the "off" period in the SPICE simulation and the measured primary voltages of Fig.3 and Fig.4(a), respectively. This waveform resembles a square wave at any duty cycle.

An important parameter in the design of the power sections of the circuit is the choice of the secondary voltage to output voltage differential. This is needed to provide headroom to compensate for a drop in the secondary voltage with increased power output, the difference being made up by the by duty cycle variation controlled by the TL494.

Secondary voltage drop has several sources: ohmic losses in inductor coils, non-linearity of the cores, 100Hz ripple due to discharge of mains storage capacitors C6 & C7 and voltage drop across C8 which is charged and discharged every switching cycle. The latter two effects contribute to a primary voltage ripple of 22V and 9V peak-to-peak respectively at full output power, which manifests as a 63V ripple across the secondary. Choosing a 100V differential allows output voltages of up 800V to be delivered by this supply at full power and regulation.

The output voltage is smoothed by a capacitive divider consisting of two 10µF capacitors (C1 & C2) rated at 450V. Alternatively, the 400V version has a higher output current and so 47µF capacitors rated at 350V (or higher) should be used.

At this rating, they are each available in a small package which is easily accommodated in the space provided on the PC board for the original 5V supply components. Their capacitance contributes only about 700mV of 60kHz ripple (0.1%) at full load.

Two 180kΩ resistors across the output set a minimum load current, ensuring that the PWM controller switches Q1 & Q2 on for at least a small portion of each period. Resistor chain R3-R6 divides down the high-voltage output, developing a lower voltage feedback signal that is applied to the non-inverting error amplifier input of the TL494.

Output voltage regulation is achieved by varying the duty cycle so that the voltage applied to the TL494's non-inverting amplifier input (pin 1) equals the voltage on the inverting input (pin 2). In this case, 2.5V is applied to pin 2 via resistive divider R7 & R8. Hence, if R6=4.7kΩ, then R3 + R4 + R5 should equal 1311kΩ for 700V output, or 747kΩ for 400V.

The filament supply is provided by a simple modified version of the original 12V secondary. Unfortunately, we can't use the TL494 to regulate the 12V supply because the original circuit used a coupled inductor shared between the secondaries for this purpose. Our two secondaries now have a high voltage between them. Hence, an LM350T adjustable 3A regulator is used to derive the 12.7V supply. It also powers the 12V cooling fan and must be fitted with a heatsink.

This secondary also supplies power to the TL494 via D7 & C5, as in the original circuit. If a 24V filament supply is required, the more common 7824 1A regulator can be used, as less current is required. The cooling fan can be run from 24V using a 47Ω 5W series dropping resistor.

When the HV supply is only lightly loaded, the duty cycle is so small that the filament supply is not able to deliver its rated current. This can occur at power-on because no plate current flows when the filaments are cold. However, without HV current the filaments can not warm up. To avoid this stalemate, an auxiliary voltage control circuit consisting of resistors R13 & R14 and diode D12 is employed.

During normal operation, D12 is

reverse-biased and the voltage at pin 1 of the TL494 is derived from the HV supply alone. However, when the filament voltage drops, the cathode of D12 becomes less positive until, at about 1.9V, the diode conducts and prevents the filament voltage dropping any further. With the resistor values shown, this threshold is set at about 10.5V.

Circuit protection

Care is required to ensure that the deadtime control circuit connected to pin 4 of the TL494 operates correctly in the modified circuit. The function of the deadtime control is to provide over-voltage and over-current protection if the transformer core saturates.

Primary side current is sensed using T3, a small current transformer. Its primary winding is connected in series with the primary of the main switching transformer. T3 employs a very large transformation ratio (n of about 180), combined with a relatively small resistance across its secondary winding.

This resistance swamps the effects of primary inductance, such that the voltage drop across the transformer is due only to the resistance. The secondary voltage is then proportional to the primary current at about 2V per amp with n = 180 and R9 = 350Ω.

The resultant signal is rectified by D10, smoothed by C10 and applied to potential divider R10 & R11. When the voltage at the midpoint of this divider exceeds about 0.6V, Q3 conducts and a positive voltage is applied to pin 4 of the TL494 through diode D11. A voltage of 0V on this pin sets a minimum deadtime of 4% while at 3.3V, Q1 and Q2 do not turn on at all.

The values shown for R10 & R11 set a threshold current of about 2.8A but you could vary this by altering these resistors. Transistor Q7 and LED1 were added to the circuit to indicate activation of the over-current protection.

Transistor Q4 and the voltage divider connected to its base provides protection against output voltage imbalances by injecting current into the base of Q3 under fault conditions. The voltage divider in the original circuit was designed to produce about 0V at the base of Q4 under normal conditions. However, since the modified supply no longer generates the negative voltages of the original circuit but still has the +12V circuit, this would upset the current balance in the resistor network. Catastrophic failures aside, output voltage regulation prevents over-voltage anyway, so the easiest solution is to disable this part of the circuit by removing the associated components (shown shaded in green on the circuit diagram).

Your circuit may use a different configuration to the one shown here. For example, the LM339 comparator is frequently used for over-voltage detection. If the voltage on pin 4 of the TL494 exceeds about 0.3V under no load, simply disconnect any resistor running from the 12V supply to the control circuitry connected to this pin.

Note that some power supplies do not use discrete components in the protection circuitry at all. Unfortunately, this article can not hope to cover all possible variations. If you do not feel confident in modifying the existing circuitry, then it is recommended that you construct the circuit shown in Fig.2 and use it to replace the protection circuits connected to pin 4.

Selecting component values

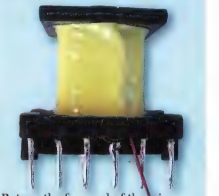
Of major importance in this design is the correct selection of filter inductor L2. If the inductance of L2 is too small, the circuit reduces to a standard capacitive voltage doubler configuration and the dependence of output voltage on duty cycle is lost. Alternatively, if it is too large, the voltage developed across it each half-cycle is insufficient to raise the current required by the load.

In practice, the optimum value is about 450μH for a 700V output (150μH for 400V).

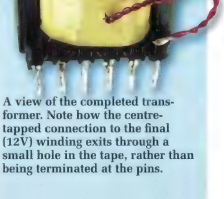
Another challenge is choosing appropriate values for the primary and secondary damper networks – R2 & C4 and R1 & C3. The former is needed to damp the leakage inductance component of the primary, which exists in all coils due to a small amount of primary flux that's not coupled to the secondary. The energy stored in this flux during the "on" period ($1/2LI^2$) generates a current which charges the transistor output capacitance and transformer stray capacitance (C_0) when the transistors turn off. In the absence of resistive losses, this energy is fully transferred into capacitive energy ($1/2CV^2$).

If the transformer is rewound as described in the construction section, it

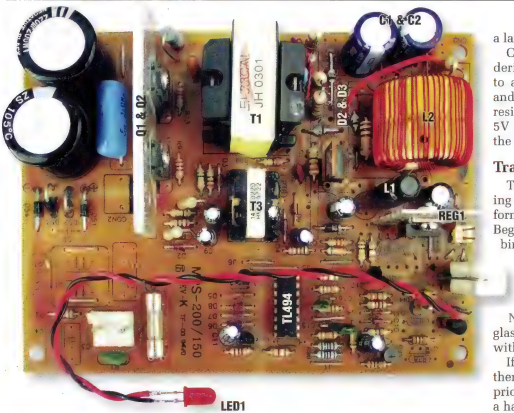
This photo and the photo immediately below show how to wind and insulate one layer of the HV secondary. The layer must start and finish on the secondary face of the former, adjacent to the PC board pins. Starting on the pin end of the former, close-wind one complete layer (no overlaps). After the layer is complete, apply about 1 and 1/4 turns of high-voltage insulation tape. Position the start of the tape approximately as shown.



Return the free end of the wire back to the start side, and then bind over it with the end of the insulation tape. The aim is to insulate the return wire from the layer beneath and the one to follow. With the return wire sealed between the two layers of tape, continue winding the next layer, or terminate at the pins if it's the final layer.



A view of the completed transformer. Note how the centre-tapped connection to the final (12V) winding exits through a small hole in the tape, rather than being terminated at the pins.



A view of the reassembled PC board showing the newly rewound transformer (T1), HV filter inductor (L2) and HV capacitors (C1 & C2). L2 can be secured to the board using non-acidic silicone sealant.

will have a leakage inductance of about 10μH. As this is less than 1% of the 3.5mH total primary inductance, it is quite acceptable. C_0 is about 270pF, while at full 150W load, the primary current can reach 1.7A.

Plugging in the values gives a voltage spike of about 350V. This adds to the voltage drop across the primary inductance during the "on" period and can destroy the output transistors if the ringing is not damped (protective diodes D8 & D9 offer limited protection due to their finite resistance and turn-on time).

The damper network has the side effect of dissipating energy not only when the transistors switch off but also when they turn on. Making the damper capacitor too large leads to the energy dissipation at turn-on far outstripping the parasitic energy.

The parasitic energy is just the energy stored in the leakage inductance and equates to a power of 0.9W at full load. We've selected a 2W resistor for R2, which leaves 1.1W to be dissipated during switch-on. A capacitor of 1nF will dissipate about 1W in R2 during the "on" period.

R2 should be 50Ω for critical damping. Making R2 smaller does not increase damping; rather, the damper capacitor effectively acts in parallel with the primary winding to change its ringing frequency.

A second source of ringing occurs when current through L2 drops to zero during the "off" period. Depending on the polarity of the half-period, either diode D1 or D2 stop conducting. However, the voltage across L2 can not change instantaneously, due to the energy stored in the diode and switching transistor output capacitance. The resultant ringing is dissipated by the damper network across the secondary and by hysteresis losses in L2.

Construction

You should read the earlier SILICON CHIP article (October 2003) on modifying a PC power supply prior to commencing construction. Note that quite a few more components need to be removed here, since most of the secondary side is unsuitable for HV operation.

Begin by removing the large low-voltage secondary capacitors and inductors. The 5V rectifier and associated heatsink also need to be removed, as well as the secondary RC damping network. The multiple power supply leads for the various output voltages are best unsoldered and removed using a large (60W) soldering iron.

Care must be taken when desoldering the ferrite transformer (T1) to avoid melting the former plastic and loosening the pins. Remove all resistors and links leading from the 5V supply to the control circuitry of the TL494.

Transformer preparation

The next job is to remove the existing windings from the ferrite transformer in preparation for the rewind. Begin by carefully removing the tape binding the core sections together, as it can be reused later. Soak the transformer in methylene chloride paint stripper overnight to remove most of sealing varnish.

Note that gloves and protective eyeglasses should be worn when working with paint stripper.

If you don't wish to wait overnight, then the transformer can be warmed prior to dipping for a few minutes with a hair drier held at close range. After about 15 minutes, the transformer can be gently removed and light pressure applied by means of a screwdriver between the slab section of the core and the former, allowing the latter to be released.

It is advisable to remove the E-section out of the former immediately by pressing gently on the centre prong of the "E" (the outer prongs are fragile and easily broken). Care needs to be taken here since this is the only component that is not easily replaced.

If the E-section won't separate with light pressure, then wash the transformer thoroughly and use a razor blade and sidecutters to slice and remove sections of insulation and copper wire to free it up. Complete the transformer disassembly by washing all components and removing all the wire and insulation from the former.

Transformer rewind

Great care must be taken with the transformer rewind to ensure primary to secondary isolation. **In particular, make sure that each layer is completely covered with the tape, right up to the shoulders of the former, so that turns from different layers can not touch.**

Except where noted, there should be no gaps between the start and finish of a layer and the shoulders of the former. This ensures that wire from the next layer can not creep into the gap

and potentially make contact with the preceding layer.

The HV secondary winding goes on first, using 28 SWG (0.4mm) enamelled copper wire. Three layers are required, producing 117 turns in total. For the 400V version, use three layers of 24 SWG wire instead, producing 75 turns in total. It does not matter if your winding is a few turns short. The inner layer is the "hotter" end of the winding. It must be connected to the third pin from the edge of the PC board on the secondary side of the former.

A layer of polyester high-voltage tape is used to insulate each layer. Suitable "3M" brand high-voltage polyester tape is available from Farnell (cat. no. 753-002). Note that this tape is 19mm wide, whereas the standard former requires 17mm tape. To obtain the correct width, stick strips about 10cm long onto a clean plastic surface (such as transparency film) and trim off 2mm using a razor blade and straight edge.

One end of the tape is placed over the top of a completed layer and the free end of the wire is returned over the top and sealed by one turn of the tape (see photos). The wire must be returned on the pin face rather than the sides of the former otherwise there will not be sufficient room for the core.

The copper strip used in the original transformer to reduce inter-winding capacitance is not needed here because the windings are not interleaved. With all three layers in place, **insulate the HV secondary with three layers of polyester high-voltage tape.**

Using the same technique, the primary is now wound in two layers with 24 SWG wire, for a total of 40 turns. Note that the first layer will be 25 turns, whereas the second layer will be only 15 turns. This leaves a gap between the finish of the winding and the shoulder of the former. Before applying the inter-winding insulation over the second layer, this gap must be filled in with tape.

To achieve this, cut strips of high-voltage tape of the appropriate width and build up the gap to the same height as the windings. The idea here is to achieve a smooth, level surface for the final winding. **That done, insulate the primary with two layers of high-voltage tape.**

Finally, the 12V secondary is wound with 12 centre-tapped turns in a single layer using 24 SWG wire and insulated with a single layer of high-voltage tape. It's easier if the centre-tap connection is not terminated at the pins (see photo).

The transformer core can now be fitted, making sure that the abutting faces are perfectly clean. This is necessary because the ferrite core is of very high permeability material (ie, μ_e about 2000). An air gap of only one two thousandths of the core length (about 25 microns) will be sufficient to halve the coil's inductance. The core sections are pressed together tightly, bound with the original tape, and the whole assembly sprayed with lacquer and left a few hours to dry.

It is best if the former pins are masked with tape prior to spraying to make subsequent soldering easier.

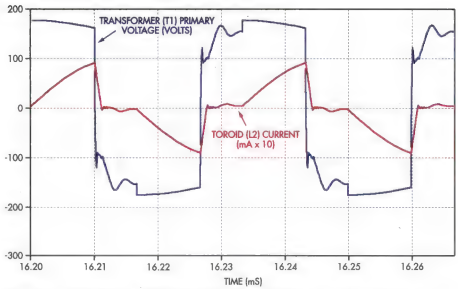


Fig.3: the output from a SPICE simulation of transformer primary voltage and toroid current waveforms. The simulation results closely follow the actual waveforms measured in the working prototype.

Toroid rewind

Toroid L2 is wound next. A key requirements for L2 are that its insulation should withstand about 500V and it must be able to dissipate the heat generated by hysteresis in its core. The latter is not to be confused with ohmic losses in the windings (which are small here) and arises because the core does not demagnetise at zero current. This remnant magnetism is removed by reverse current every cycle and manifests itself as heat. In practice, hysteresis losses can be reduced by using a larger core size for a given value of inductance.

With this in mind, L2 consists of two standard 25 x 10mm toroids glued at the faces to form a single core. This gives the required inductance in a single layer and reduces hysteresis heating. Suitable core material is the standard yellow/white or green/yellow ferrite typically used in PC power supplies.

The original low-voltage windings are discarded and the faces of the toroids thoroughly cleaned before gluing. L2 is wound in a single layer with 56 turns of 24 SWG wire. For 400V versions, use 33 turns of 24 SWG wire.

In operation, the core should only get warm to the touch at full power (make sure you turn off the converter before checking this!).

PC board rebuild

All of the necessary components can now be installed on the PC board.

The HV section occupies the area previously taken up by the 5V supply. Although the exact PC board layout varies between manufacturers, a typical design allows easy accommodation of all the components shown in Fig.1. However, you might need to break a few copper tracks with a sharp knife or engraver tool and add a few links with insulated hook-up wire.

Important: be sure to leave at least 1mm clearance between all high-voltage tracks in this part of the circuit.

Remember to install the resistive divider from the HV supply to pin 1 of the TL494 in place of the original divider running from the 5V supply. Inductor L4 and capacitor C9 are mounted directly across the rear of the output terminals (see photos).

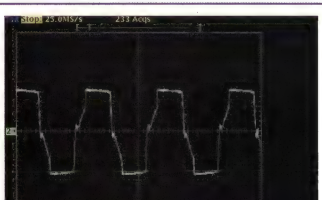


Fig.4(a): this scope waveform was measured across the primary of transformer T1 and shows the alternate switching of transistors Q1 and Q2. Notice how the secondary voltage clamp has flattened the peaks of the waveform to produce a square-wave voltage that's independent of the duty cycle. Note also that the waveform peaks are slanted slightly due to the discharging of C8.

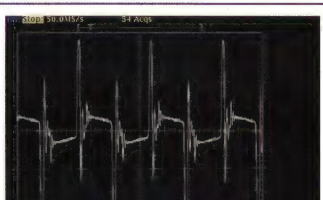


Fig.4(b): the voltage across toroid L2 over several cycles. The peaks of about 370V occur during the "off" period when L2 discharges into the smoothing capacitors (C1 & C2). Some ringing occurs when the current drops to zero, as described in the text. During the "on" period, the voltage across L2 equals the difference between the secondary and output voltages, decreasing steadily as C8 is charged.

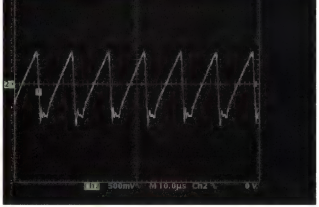


Fig.4(c): 60kHz output ripple at full load is about 2V p-p at 700V DC.

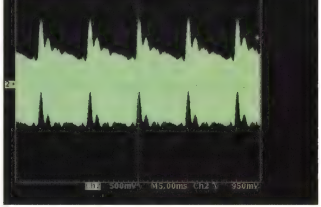


Fig.4(d): 100Hz hum can be seen on top of the 60kHz ripple and amounts to only about 0.6Vp-p.

Note: for safety reasons, these waveforms were all taken with the SMPS connected to the mains via an isolation transformer. Don't attempt this unless you know exactly what you are doing.

The inductor consists of 5-6 turns of hookup wire wound around a small toroid.

The 12V circuit occupies its previous location but make sure that all components not shown in Fig.1 are removed. The 4µH inductor (L3) can be salvaged from the original 5V supply and consists of 7-8 turns of copper wire around a ferrite rod.

Once you are certain that no HV is fed anywhere except as shown in Fig.1, you are ready to apply power to the circuit. It would be useful to have a load available to check operation at reasonable power levels. I used several strips of five 4.7kΩ 5W resistors connected in series to provide a 25W per strip load at 700V.

Warning: switchmode power supplies have been known to explode on failure, expelling particles of component material such as metal, epoxy and glass at high speed. Close the case or wear protective eyeglasses before applying power!

If the circuit fails to deliver substantial power, the problem might be due to the current protection circuit. Check that the voltage on pin 4 of the TL494 does not exceed about 0.3V under normal load. If it does, this part of the circuit is malfunctioning. Follow the techniques described in the circuit protection section above to track down the problem.

Finally, because the modified converter is less efficient than the original, it requires better cooling when operating at full power. This can be achieved by switching the cooling fan around so that it forces the air into the case. SC

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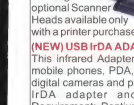
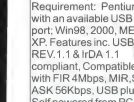
$49. We have a limited number of Print Heads/ Cartridges. The optional Scanner Heads available only with a printer purchase.



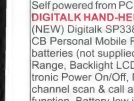
(NEW) USB IrDA ADAPTER:

This infrared Adapter is a wireless interface for mobile phones, PDA, Palm pilots, notebook PC, digital cameras and printers etc. Includes USB to IrDA adapter and USB cable. System Requirement: Pentium I or compatible IBM PC with an available USB port; Win98, 2000, ME, XP. Features inc. USB REV.1.1 & IrDA 1.1 compliant, Compatible with FIR 4Mbps, MIR,SIR & ASK 56Kbps, USB plug & play. Self powered from PC. $33.(IRDA1)



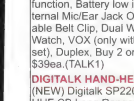
DIGITALK HAND-HELD 40CH TRANSCEIVER:

(NEW) Digitalk SP3380D, 40 Channel UHF CB Personal Mobile Radio, requires four AAA batteries (not supplied).Features inc. Up to 5k Range, Backlight LCD Display, Electronic Power On/Off, Menu Function, channel scan & call alert, key lock function, Battery low indicator, external Mic/Ear Jack Output, Removable Belt Clip, Dual Watch, Stop Watch, VOX (only with optional Headset), Duplex, Buy 2 or more for $35ea. $39ea.(TALK1)



DIGITALK HAND-HELD 40CH TRANSCEIVER:

(NEW) Digitalk SP2202AA, 40 Channel UHF CB Long Range Transceiver, requires 4X AAA batteries, not supplied. Features inc. up to 8k Range, Back-light LCD Display, High/Low Power Selection, Electronic Power On/OffMenu Function, Channel Scan & Call Alert, Key Lock Function, Battery Low Indicator, External Mic/Ear Jack Output, Removable Belt Clip, Dual Watch, Stop Watch, VOX (only with optional Headset), Duplex, Buy 2 or more for $80ea· (TALK2) $90ea. Some accessories (headsets etc.) for talk1 & 2 may be available soon.



NEW ELECTRIC GOLF TROLLEY

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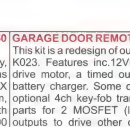
With a 150 Watt Electric Motor and 12V/17aH battery this trolley will travel a distance of 18-20km Folds away for transport or storage.

GARAGE DOOR REMOTE CONTROL KIT.

This kit is a redesign of our popular garage remote K023. Features inc.12VDC out for door / gate drive motor, a timed output for a light, built in battery charger. Some of the new features inc. optional 4ch key-fob transmitter (TX7), optional parts for 2 MOSFET (latching or momentary) outputs to drive other devices such alarms & driveway lights etc. independent of the door / gate operation. K023A. $39. Output kit K023AO. $12. Suitable Power adaptor. $6. Battery. PB6 $25.



TVS $11

REDUCED PELTIER DEVICE PRICES!!!

Dim: 40 x 40 x 4mm.
GP1 4.0A Device / D T 65° / Qmax 42W, $10
GP2 6.0A Device / D T 65° / Qmax 60W: $13
GP3 8.0A Device / D T 65° / Qmax 75W: $16

(NEW)MOBILITY SCOOTERS

Finally!!! High quality mobility scooters for the elderly & the disabled at an affordable price. (MSC)$950

Dim.:1430(overall) X 677(width) X 1200(height)
N.W.: 103.95kg (Inc. 2 Batteries:30kg). Max. fwd Speed: 6-10km/h. Max. bwd Speed: 2.4 - 4.8km/h Climbing capability: 12° Max.load capacity: 140kg Motor: 24V 450W // (0.6Hp). Range on 1 full charge: 40km - 55km Charger: 240VAC/24VDC.

100W SCOOTER REAR DRIVE PARTS

These are the drive components from our 100W scooter including the motor, toothed belt, pullies & rear wheel/ axle assembly. Ideal for robotics projects (SCD1) $28

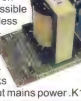
SUPER PRICES ON NEW UHF MODULES

Cheep home automation with these new miniature UHF modules. Band width limited to 1.2kbs.
(TX434) $9
(RX434LC)$9

IT"S BACK!!!

NEW 12V CFL INVERTER KIT.

This is a redesign of our popular CFL kit and is designed to power 1 or a combination of compact fluorescent lamps up to 20W to 50W or more with some small push-on heatsinks. It is now possible to buy some CFLs for less than $5ea from supermarkets and discount stores making this kit great for cheep alternative lighting for shacks & week-enders without mains power .K111B. $22



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paul@oatleyelectronics.com

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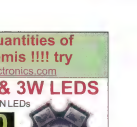
1W $13.90.
3W $19.90.

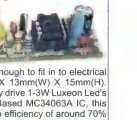


MINI DRIVER KIT FOR LUXEON LEDS FOR UNDER $9

This small driver kit is small enough to fit in to electrical conduit measuring 65mm(L) X 13mm(W) X 15mm(H). This kit is designed to efficiently drive 1-3W Luxeon Led's from a 7-20V power supply. Based MC34063A IC, this switch mode driver kit gives an efficiency of around 70% @ 12V. Kit inc. PCB & all on-board parts.(K207) $8.90...

NEW MINI HIGH QUALITY LOW LIGHT CMOS PINHOLE

CAMERA (COLOUR with audio): Measures 20 x 20 x 20mm: (CAM1B) $49. Ask for a free VHF video modulator (K063B) or for $5 more, an audio / video modulator (mod1).



ELECTRIC BIKES/SCOOTERS

(SC1) ELECTRIC SCOOTER

Unlike some others these have Australian approvals inc."C" TICK. (SC1). This portable light weight scooter folds up for easy carrying & storage. Features include variable speed control, hand lever style brake. Brake & throttle can be swapped from side to side. Telescopic handlebars. Complete with mains charger & batteries. **Speed:** 12km/h, **Motor:** 100W, **Battery:** 12V x 2, 4.5A, **Range:** ~14km, **G.W:** 10kgs **N.W:** 9kgs **Meas:** 740X130 (deck) x 930mm. **NOTE:** These scoters are not toys & should only be used under competent supervision & only where allowed by local authorities.

ELECTRIC BIKE

(SC2) ELECTRIC BIKE:

This is an excellent electric bike with a robust design & good power. Comes with 2 X 12 volt batteries & 200 watt motor, cruises at 18km/h for approximately 20km. Features inc. variable speed, adjustable handlebars & seat, lights, inflatable wheels, side stand, helmet box & more. It comes complete with charger. Unlike some these have Australian electrical approvals inc. C-TICK. **Speed:** 18km/h, **Motor:** 250W, **Battery:** 12V 12AH, **Range:** ~20-35km, **G.W:** 27KGS **N.W:** 24kgs.

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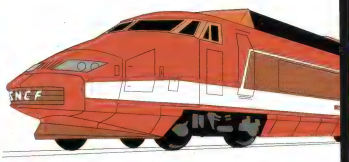
SC_JUL_04

D-I-Y remote control for a model train layout



With the aid of a pair of UHF receiver & transmitter modules, this simple circuit provides direction, acceleration and braking controls for a model train layout. It could be used for a garden railway or with HO and N layouts as a "walkround" throttle.

By GREG HUNTER

PICAXE LISTING

```
'-----------------------------------------------------------
'Train motor controlier for use with Picaxe 08 micro and
'Oatley TX7 & RX7 UHF remote control modules.
'23/2/04
'-----------------------------------------------------------
'assumes 4 outputs from R/C (active high inputs to picaxe)
'Accelerate      - pin 2
'Brake           - pin 3 (input only)
'Forward         - pin 4
'Reverse         - no pin

'2 outputs from picaxe
'Motor           - pin 0 (output only)
'Reverse relay   - pin 1 (is also the analog capable pin)
'-----------------------------------------------------------

symbol motor=0                  'motor is pin 0
symbol relay=1                  'reversing relay on pin 1

symbol rawspeed=b0              'value 0 to 255 (max speed)
symbol MARK=b1                  'MARK is motor on time
                                '0 to period = rawspeed*Period/256
symbol Space=b2                 'SPACE is Period-MARK
symbol k=b3                     'loop counter
symbol Period=16                'ms of motor control period MARK+SPACE=Period
symbol Numloops=8               'loops before reading inputs
                                'ACCTC=10s  time to go from 0 to full in sec
                                'BRTC=5s  time to stop from full speed in sec
symbol ACCstep=4                '(10s)  '=255*Numloops*Period/ACCTC/1000
symbol BRstep=6                 '(5s)   '=255*Numloops-Period/BRTC/1000
symbol Maxspeed=224             'define when reached max speed...

'-----------------------------------------------------------
'read input buttons, do direction first.
```

continued on page 86

THE BASIC SPECIFICATIONS of this circuit are as follows:

(1) The transmitter has four buttons, labelled A, B, C & D. Pressing and holding "A" (accelerate) will slowly increase the track voltage. If held for about 8s, the voltage will reach the maximum. If "A" is released at any time before the maximum voltage is reached, that level will remain indefinitely.

(2) Pressing and holding "B" (brake) for about 6s will reduce the voltage to zero. Again, if "B" is released at any time, the voltage will remain at that level indefinitely.

(3) As the voltage reduces to less than 1/8th of maximum, the control becomes "finer". As a result, "B" must be held for another 2s to reduce the voltage by the last 1/8th. This allows better shunting control.

(4) Pressing button "C" for about 0.5s will select one direction of travel. Pressing "D" for 0.5s will select the other direction. These will work only if the speed is less than 1/8th of maximum.

(5) If "C" or "D" are pressed when the voltage is greater than 1/8th maximum, this will result in an "emergency brake" application. This results in the output voltage being reduced from maximum to zero in 1s.

The unit can be inserted between the existing train controller and the track to provide "walkround" control. If necessary, it could also be powered from a separate transformer.

Pulse-width modulation

Essentially, speed control is achieved by pulse-width modulating the motor drive voltage via a MOSFET switch (Q2). To control motor direction, the polarity of the applied volt-

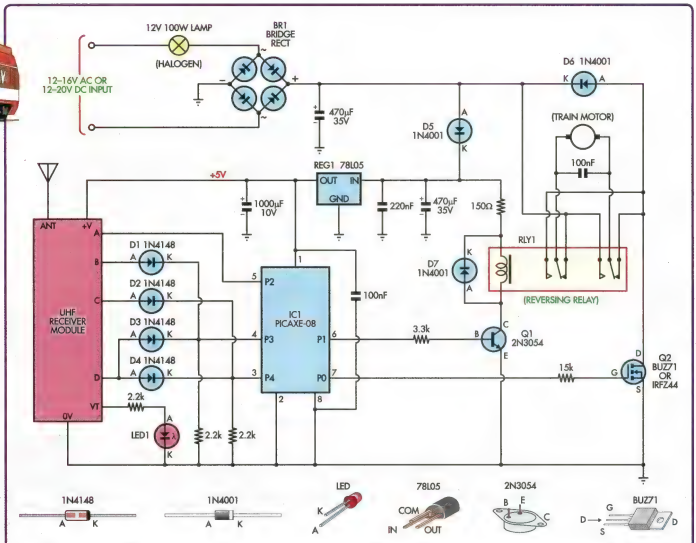


Fig.1: the circuit uses a standard UHF radio link to apply command signals to a Picaxe-08 microcontroller (IC1). IC1 provides PWM signals to MOSFET Q1 to control motor speed and switches relay RLY1 to control the motor direction.

age is switchable with a DPDT relay (RLY1). Both of these functions are managed by a Picaxe-08 microcontroller, which receives its commands from the 4-button remote control over the UHF radio link.

In more detail, the circuit receives input power via a 6A bridge rectifier (BR1). A 12V, 100W halogen lamp is included in series with the supply to limit short-circuit current, so protecting the MOSFET switch. A 470µF capacitor provides some filtering of the supply before it is applied to the motor circuit.

Supply filtering

Filtering of the motor supply was found necessary because without it, hunting was apparent. The capacitor value may need to be increased for large loads but note that this will

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PICAXE LISTING – continued from page 84

```
buttons:
  if rawspeed>16 and pin4=1 then Emergency   'trying to reverse at speed=STOP!
  if rawspeed>30 then accel                  'if moving, don't look at reversing!
  if pin4=1 and pin3=0 then forwarder        'forward Tx button pressed
  if pin4=1 and pin3=1 then reverser         'reverse Rx button pressed -
  goto accel                                 'no call for direction change

Emergency:
  PAUSE 10                                   '10ms delay to ensure is not interference
  if pin4=0 then buttons
  rawspeed = rawspeed/2                      'emergency brake if hit direction buttons
  goto control                               'will stop from max in 1/2 sec approx.


forwarder:
  LOW relay                                  'de-energise rev relay
  goto accel

reverser:
  HIGH relay                                 'energise rev relay
  Pause 500                                  'delay so that if pin4 released before pin3
'                                            'it doesn't go back to Forward direction.

'------------------------------------------------------------
'now look at accel and brake buttons

accel:
  if rawspeed>=MaxSpeed then chkBrakeButton  'already at top speed
  if pin2=1 then speedup
  if rawspeed<16 then control                '0-15 means already stopped.
'                                            '(Note: 16=256/Period)
  goto chkBrakeButton

speedup:
  rawspeed = rawspeed+ACCstep                'increase raw speed by step chosen.
  goto control

chkBrakeButton:
  if pin3<>1 then control                    'brake button not pressed.
  if rawspeed<48 then reduceBr               'reduce brake rate for last two speed steps
  rawspeed = rawspeed-BRstep                 'decrease rawspeed by usual step
  goto control

reduceBr:
  rawspeed=rawspeed-2                        'reduce brake rate as approach stop

'------------------------------------------------------------
'now send control pulse to motor

control:
  if rawspeed<16 then buttons                'stopped so don't process motor
  MARK = rawspeed/16
  Space = period-MARK

  for k=1 to numloops
  High motor
  if rawspeed>=MaxSpeed then buttons         'leave on all the time for max speed
  pause MARK                                 'motor on pulse for MARK ms
  Low motor
  Pause Space
  next k

  goto buttons
```

increase the average voltage and may effect the resolution of the 16-step speed control system.

Diode D5 feeds the DC input to a 5V regulator (REG1) which is used to power the remaining circuitry. Additional bulk filtering is provided by 470µF and 1000µF capacitors on either side of the regulator.

As mentioned above, motor speed is controlled by pulse-width modulating a MOSFET switch (Q2) in series with the motor. The gate of the MOSFET is driven directly from the output of the Picaxe on leg 7 (internal pin 0). For large loads, a "logic-level" type FET should be substituted here to ensure that it's switched fully on with only 5V at the gate.

The reversing relay (RLY1) is a DPDT 12V/1A type with a 330Ω coil. It's driven from leg 6 (internal pin 1) via a 3.3kΩ resistor and 2N3054 transistor (Q1). The coil has a 270Ω resistor in series for higher voltage operation. This resistor can be omitted if the supply rail is less than about 14V.

Receiver outputs

The receiver has four outputs, corresponding to the four buttons on the transmitter (A-D) as described above. These outputs are normally low, going high when the matching transmitter button is pressed. Also included is a "VT" (valid transmission) output. This is used to drive LED1 on the circuit, which illuminates when ever a valid button press is received from the transmitter.

With only five input/output pins available on the Picaxe-08, it was necessary to combine the "B", "C', & "D" inputs from the receiver into two lines using diodes D1-D4. The program code running in the Picaxe is then responsible for determining which of the three lines is active.

The 433MHz UHF transmitter and receiver pair are available as pre-assembled modules from Oatley Electronics, part numbers TX7 and RX7 – see **www.oatleye.com** for more information. Be sure to set the address (code) links on both modules as per the supplied instructions.

Program listing

The complete program listing for the Picaxe is included with this article. Note that a 16ms period was chosen for the variable mark/space (PWM) drive to MOSFET Q2 to avoid motor cogging at low speeds, as well as to allow enough time for other tasks.

The "rawspeed" variable holds the basic motor speed value. Note, however, that the "motor on" portion of the period is 1/16th of this, resulting in 16 possible motor speeds.

The rates of acceleration and braking (labelled "ACCTC" & "BRTC") determine how many of the basic counts (of 255) are added or subtracted each time a button is read. SC

PRODUCT SHOWCASE

New range of hobby tools from DSE

Dick Smith Electronics have recently introduce a range of specialised handy power tools which will make any hobbyist's life a lot easier!

Included in the range is a 40-piece Rotary Tool Kit (below) which includes the tool itself, an extension attachment, plus collets, grinders, engravers, sanders, drills and buffing attachments, all housed in a handy carry case. It normally sells for $34.92 but

and more.

It is priced at $24.87.

All three items are available through Dick Smith Electronics or PowerHouse stores or via DSE Mail Order or their website.

at press time was on special at $24.92 (Cat T4823).

Similarly on special (in fact, at the same price) is a Detail Sander Kit (Cat T4822, shown at right). Palm-sized, it is also housed in its own case and comes with ten sanding disks, a foam sheet and scouring sheet.

The third item is a Heat & Strip Hot Air Blower (Cat T4821) which is said to be ideal for shrinking heatshrink tubing (yes, it is!), removing old paint, removing vinyl tiles, loosening rusted or over-tightened nuts, drying items

Contact:
Dick Smith Electronics (all stores)
Reply Paid 500, PO Box 500,
Regents Park DC NSW 2143.
Tel: 1300 366 644 **Fax:** (02) 9642 9155
Website: www.dse.com.au

First Aussie PICAXE book?

MicroZed Computers have submitted what they claim is the first PICAXE book to be written in Australia. In fact, "Experiments in Mechatronics Using the PICAXE Microcontrollers", by Australian teacher and author David Lincoln, is already in its second edition.

Priced at $26.00 inc GST, the 94-page book has 33 PICAXE-08 and 19 PICAXE-18 experiments. It is available direct from MicroZed or from Altronics, Jaycar and School Electronics Supplies in Australia, and South Island Components and Surplustronics in NZ.

Contact:
MicroZed
PO Box 634, Armidale NSW 2350
Tel: (02) 6772 2777 **Fax:** (02) 6772 8987
Website: www.microzed.com.au

Powered PA Speakers

Available in either 12-inch or 15-inch models, Altronics' new 165W powered PA speakers are housed in rugged wedge-shaped nylon fibre and ABS moulded cabinets. While lightweight, they offer extreme durability and strength.

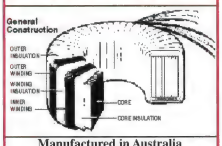
The horn flare is moulded as part of the cabinet and fitted with a titanium diaphragm compression driver. The main bass speakers are manufactured with rugged heavy duty diecast aluminium frames.

240VAC powered, they accept XLR balanced or 6.35mm unbalanced mic input and XLR or RCA line level input. Each unit also has XLR and 6.35mm line out connectors, allowing multiple powered speakers to be 'daisy chained' from a single input source.

Recommended retail prices are $699 and $899.

Contact:
Altronics Distributors
Box 8350, Perth Business Centre 6849
Tel: 1300 797 007 **Fax:** (08) 9428 2187
Website: www.altronics.com.au

TOROIDAL POWER TRANSFORMERS



Manufactured in Australia
Comprehensive data available

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Multi-homed ADSL router

ADSL internet connection is great. High speed, always on line, ultra-reliable . . .

Oh, disagree with that last one, do you? You're not alone. ADSL dropout is much more common than your ISP would care to admit. That's why this neat router from Microgram Computers will be so welcome.

This multi-homed router allows the connection of two different ISPs, doubling your chances of staying online.

It features load balancing and failover between the WAN lines and also has a 4-port 10/100 hub built in. It supports up to 253 users and has a throughput of up to 20Mb/s

OK, it means that you're going to have to pay for two ISPs but if having your ADSL internet always on line is important to you and/or your business, this will be a small price to pay.

The Multi-Homed ADSL Router (Cat No. 10145-14) has a recommended retail price of $399.00. A PDF data sheet is available from the Microgram website.

Contact:
Microgram Computers
1/14 Bon Mace Cl, Berkeley Vale 2261
Tel: (02) 4389 8444 **Fax:** (02) 4389 8388
Website: www.microgram.com.au

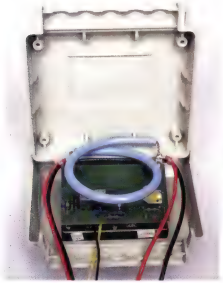
Oatley's economy panel meters

Oatley Electronics have a new kit which turns one of their low-cost digital panel meters into a highly useful digital voltmeter or ammeter.

The K212 Panel Meter Interface kit comes with components including a shunt to measure 20A and a divider to measure 12V, with a wide range of adjustment.

It also has a built in DC-to-DC isolated power supply to power the Digital Panel Meter at a very economical 3-5mA. This low current helps to reduce the drain on solar systems, etc.

The PC board is the same size as the meter and is designed to solder to and stack on the back of the DPM.

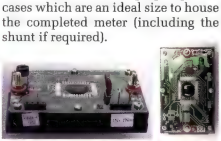


A typical application for this kit would be to monitor solar systems, monitor charge/drain and voltage.

Other applications include thermometer, PH meter, db meter, lux meter, etc

The K212 Panel Meter Interface kit sells for $9.00, incidentally the same price as the pre-assembled digital panel meters.

When both the DPM and Interface kit are ordered together, Oatley will include one of their flip-open plastic cases which are an ideal size to house the completed meter (including the shunt if required).



Contact:
Oatley Electronics
PO Box 89, Oatley NSW 2223
Tel: (02) 9584 3565 **Fax:** (02) 9584 3561
Website: www.oatleyelectronics.com

Jaycar's digital Sound Level Meter

Earlier in this issue we mentioned that we borrowed a Sound Level Meter from Jaycar Electronics to do some "before and after" sound level measurements on noisy PCs.

It worked so well we thought it should at least rate a mention in the products pages, as we're sure many readers would have applications for a good, low-cost sound level meter – such as PA/sound installation, office noise monitoring, acoustic checking, pro hifi level setup and so on.

Retailing at $157.95, the QM1588 Sound Level Meter comes in its own soft-foam-lined carry case and features a 3-1/2 digit, 17mm high LCD.

It has settable fast and slow response times, A and C weighting and an in-built calibration circuit. Frequency range is from 31.5Hz to 8kHz and it has low (35-100dB) and high (65-130dB) ranges. Resolution is 0.1dB.

The foam windshield is removable and the unit has a 3/8-inch thread to suit a standard tripod.

Size is 253 x 64 x 29mm and the combined instrument and case weight is only 620g. It's powered by a single 9V battery (supplied).

Contact:
Jaycar Electronics
PO Box 6424, Silverwater NSW 1811.
Tel: (02) 9741 8555 **Fax:** (02) 9741 8500
Website: www.jaycar.com.au

SILICON CHIP WebLINK

How many times have you wanted to access a company's website but cannot remember their site name?

Here's an exciting new concept from SILICON CHIP: you can access any of these organisations instantly by going to the SILICON CHIP website (www.siliconchip.com.au), clicking on WebLINK and then on the website graphic of the company you're looking for. It's that simple. No longer do you have to wade through search engines or look through pages of indexes – just point'n'click and the site you want will open!

Your company or business can be a part of SILICON CHIP's **WebLINK**. For one low rate you receive a printed entry each month on the SILICON CHIP **WebLINK** page with your home page graphic, company name, phone, fax and site details plus up to 50 words of description – and this is repeated on the **WebLINK** page on the SILICON CHIP website with the link of your choice active. Get those extra hits on your site from the right people in the electronics industry – the people who make decisions to buy your products. Call SILICON CHIP today on (02) 9979 5644

JED designs and manufactures a range of single board computers (based on Wilke Tiger and Atmel AVR), as well as LCD displays and analog and digital I/O for PCs and controllers. JED also makes a PC PROM programmer and RS232/RS485 converters.

Jed Microprocessors Pty Ltd
Tel: (03) 9762 3588 Fax: (03) 9762 5499
WebLINK: jedmicro.com.au

We endeavour to provide a range of technical books of interest to the Radio Amateur as well as electronics enthusiasts, at competitive prices. Special discounts are offered to WIA members. We are the only bookshop of this type in Australia

Wireless Institute of Australia (VK2)
Tel:(02) 9689 2417 Fax: (02) 9633 1525
WebLINK: wiansw.org.au/bookshop/

At **QUESTRONIX** we specialise in conversion, switching and distribution equipment for VGA, video and audio. We have been serving the audiovisual industry as well as pro, semi-pro and domestic a-v equipment users since 1988. As well as being a 100% Australian manufacturer we also import a range of innovative and interesting items.

QUESTRONIX
Tel: (02) 4343 1970 Fax: (02) 4341 2795
WebLINK: www.questronix.com.au

We specialise in providing a range of Low Power Radio solutions for OEM's to incorporate in their wireless technology based products. The innovative range includes products from MK Consultants, the world-renowned specialist manufacturer.

TeleLink Communications
Tel:(07) 4934 0413 Fax: (07) 4934 0311
WebLINK: telelink.com.au

Our website is updated daily, with over 5,500 products available through our secure online ordering facility. Features include semiconductor data sheets, media releases, software downloads, and much more

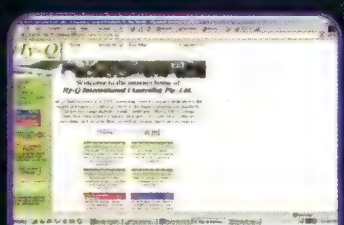
JAYCAR ELECTRONICS
Tel: 1800 022 888
WebLINK: www.jaycar.com.au

For everything in radio control for aircraft, model boats and planes, etc. We also carry an extensive range of model flight control modules including GPS, altitude and speed, interfaces, autopilot and groundstation controllers. More info on our website!

Silvertone Electronics
Tel/Fax: (02) 9533 3517
WebLINK: silvertone.com.au

International satellite TV reception in your home is now affordable. Send for your free info pack containing equipment catalog, satellite lists, etc or call for appointment to view. We can display all satellites from 76.5° to 180°.

Av-COMM Pty Ltd
Tel:(02) 9939 4377 Fax: (02) 9939 4376
WebLINK: avcomm.com.au



A 100% Australian owned company supplying frequency control products to the highest international standards: filters, DIL's, voltage, temperature compensated and oven controlled oscillators, monolithic and discrete filters and ceramic filters and resonators.

Hy-Q International Pty Ltd
Tel:(03) 9562-8222 Fax: (03) 9562 9009
WebLINK: www.hy-q.com.au

New digital cameras from Fuji, Sanyo

Fuji and Sanyo have recently both announced new digital cameras.

The 3.1 million effective pixels **Fuji** FinePix A120 (below) also has movie recording capability of up to 10fps for 60 seconds at 320 x 240 pixels or up to four minutes at 160 x 120 pixels using the 16MB xD Picture Card (included).

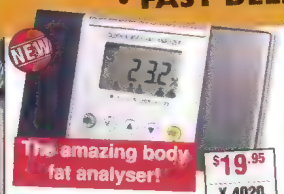
Recommended retail price is around $239, including GST.

Sanyo's new 128 gram digital, the VPC-J4 (above right), has a 4 megapixel CCD, precision optics, a 2.8x internal zoom lens and a fast 0.08 second startup. Shutter speed is ½ to 1/2000 second. It has real-time interpolation to 8 megs and can also shoot 30fps video (VGA). For first-time users, it has a talking navigation audio guide.

The VPC-J4 is available in three colours and has a recommended retail price of $599.00

Both cameras are available at better photographic resellers. **SC**

NOW SHIPPING ORDERS TO ALL NSW CUSTOMERS DIRECT FROM SYDNEY!
• FAST DELIVERY • LOCAL PRODUCT SUPPORT



$19.95
X 4020

Monitor your health & fitness

Get instant feedback on the effectiveness of your diet & exercise program. Includes memories for up to 6 people. Simple to use, just enter your weight & height! Plus inbuilt alarm clock.

$150
RRP $179
A 2451

Add cinema sound to your Home Stereo

Enhance your sound system! Add a touch of realism to your favourite video or DVD!

Turn your lounge room into a cinema with your very own custom subwoofer. Module is fantastic for building into custom subwoofer cabinets. Fully featured,with volume, crossover frequency control, phase switch, high and low level outputs. Stable into 4 ohms.

CHECK THIS OUT!
A great package deal! For just $200 you get:
1 x A 2451 Subwoofer module
2 x C 3024 8" PECC Woofers
Valued at $317 normally! **SAVE $117!** (A 2451S)

B&W Video Door Phone

Check who's at the door before opening it!

$189
RRP $199
S 9410

A fantastic way to monitor your front door ***day or night!*** When the call button is pushed by your visitor the base station will show vision of your visitor and allow them to speak with you directly. Coupled with a **S 5385** ($40) you can even remotely unlatch your front door/gate to let visitors in. Extra base station, S 9411: $169

SUPPLIED WITH CABLING & POWER SUPPLY: NOTHING MORE TO SPEND!

Waterproof 7xLED torch

Keep one handy in the glove!

NEVER CHANGE A GLOBE AGAIN!

Powered by 7 high power Japanese made LEDs (rated at 100,000hrs), it can operate for up to 30hrs with just one set of batteries! Fantastic for divers, hikers, campers etc! Waterproof to 30m. Includes 4 x AA batteries.

$39.95
RRP $49.95
X 0200

Measure body temperature without fuss!

Measure body temperature at the push of a button! Great for checking kids, even infants - no pain or annoyances. An inbuilt fever alarm advises you when temperature is dangerously high. Supplied with 20 disposable hygenic covers. **A must for the coming flu season!**

$39
X 4030

DON'T PAY A FORTUNE ELSEWHERE FOR THIS FIRST AID KIT ESSENTIAL!

TAKE ADVANTAGE OF FREE ENERGY FROM THE SUN!

SAVE MONEY! CREATE YOUR OWN POWER SOURCE FROM THE SUN!

These long life polycrystalline solar panels provide a reliable & economical alternative power source. Incredibly robust with aluminium frames & tempered glass panelling for installations in the most demanding environments. 55,80 &150W incorporate triple junctions for optimised performance in low light. All include waterproof junction box and blocking diode. **See page 232 of our catalogue for more info.**

Solar Panels	1up
N 0005 5W	$116
N 0012 12W	$207
N 0020 20W	$279
N 0055 55W	$599
N 0080 80W	$799
N 0150 150W	$1450

Autoranging DMM

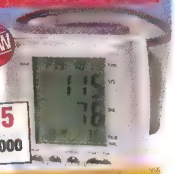
GREAT PRICE! SUPERB FEATURES!

$20
RRP $26.95
Q 1130

This great autoranging multimeter allows handsfree operation when testing! Great for working in tight spaces or for those who just want added convenience. ***INCLUDES A 1300°C TEMPERATURE PROBE FOR NO EXTRA COST!***

Features: • Manual override of auto-ranging • Data hold • Backlit display • AC/DC volts • Resistance • Continuity • AC/DC current • Transistor & diode checker

Keep a keen eye on your blood pressure



Portable, compact and accurate!

At the touch of a button it inflates around your wrist and measures your systolic, diastolic and heart rate. An in built memory records your progress from week to week! Great for anyone with blood pressure problems.

$75
X 4000

An essential tool in monitoring your wellbeing! WHY PAY UP TO 50% MORE ELSEWHERE?

Digital LCD Solar Regulator

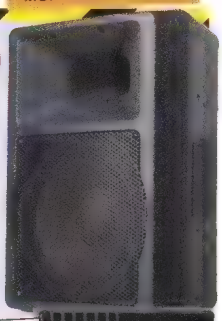
MASSIVE 20 AMP CAPACITY!

$179
N 2071

Provides optimal charging voltage & current for wet cells & seal lead acid batteries. Its microprocessor controller has 3 charge stages ensuring proper battery maintenance as well as a deep cycler for wet cells. Other features include, overcharge & temp protection, low voltage disconnect, back current protection, over discharge & polarity protection and dusk/low light detection.

Unlike other regulators, you can see the true charging status at a glance!

HIGH POWER STAND-ALONE PORTABLE PA!



The all in one answer to your public address requirements!

Available in 12" or 15" models these powered PA units provide plenty of clean, crisp and LOUD sound for addressing large crowds at events, rallies, fetes, demonstrations, fairs. Fantastic sound reproduction makes them the perfect choice for schools, DJ's, clubs, pubs etc. **Versatile, lightweight & built to last!** Features: • Moulded ABS cabinet • 6.35mm/XLR Mic input • RCA line input • Bass & treble controls • "Daisy chain" multiple units together.

$699
C 1006
12" 130W

$899
C 1010
15" 170W

SUPER FREEBIE! Receive a C 0380 Handheld Microphone & 4.5m XLR lead with every C 1006 or C 1010 sold! Valued at $59!

Measure distances at the press of a button!

This fantastic digital ultrasonic tape measure tells you distances in an ***INSTANT!*** Super easy operation makes it perfect for builders, installers etc. A handy built in laser allows you to see exactly what you're measuring! Max distance 13m.

$35
RRP $44.95
T 2250

Pro Hi-Fi RCA plugs

ALL METAL CONSTRUCTION! Featuring a spun aluminium body with spring loaded contacts ensuring the earth connects first.

$10pr
RRP $6.95ea
P 0241 Red
P 0242 Black

Transmit audio & video in your home

The easy cable-free way to transmit audio and video. Sends clear vision and hi-fi sound to another location whilst the infra red repeater allows you to control your audio equipment remotely. Fantastic for security or home theatre/hi-fi use. Supplied with two plugpacks to suit.

$115
RRP $139
S 9360A

FANTASTIC PRICE! This product even SAVES you money! Why buy 2 DVD players? Or 2 satellite decoder boxes?

Datalogging Digital Multimeter

The one meter that stands out from the rest! A magnificent meter packed with too many features to list here! Its internal datalogging memory can record up to **32000** events! • Optical RS232 • Adjustable sampling time • High/low alarm output • -50° to 1300°C • External 12VDC input • Frequency • Duty cycle • Data hold & run • Thick rubber holster • ***AND SO MUCH MORE!***

See www.altronics.com.au

$389
Q 1190

SUPER ACCESSORY PACK!
Supplied with PC software, optically isolated RS232 interface PLUS 2 temperature sensors!

Create your own PCB's and save a fortune!

Includes aeration pump, heater and clips for suspending PCBs in the etchant.

Get first class results from one-off PCBs with this easy to use etchant tank. Ensures efficient, clean and safe etching.

FREE *bottle of Ammonium Persulphate etching chemical (H 0802)! Valued at $12.55*

$89
T 3200

TURN AA's INTO C'S & D'S

Now there's no need to keep a set of different size batteries on hand. These simple adaptors accept 1 AA battery and turn it into a C or D size! Packs of 4.

$3.95
AA-C
S 4607

$4.95
AA-D
S 4609

NOW YOU CAN USE YOUR AA'S IN JUST ABOUT ANYTHING BATTERY POWERED!

60 & 100MHz Dual Trace Oscilloscopes

NEW

Includes 2 quality probes at no extra cost! Normally valued at $74.70!*

With the increasing complexity of electronic circuits a high quality oscilloscope is an absolute necessity for service technicians & engineers.

Features: • 2 year warranty • Wide bandwidth and high sensitivity • Very low power consumption • High sensitivity X-Y mode • Z axis (intensity modulation) • Simultaneous display of original and magnified waveforms on each input • Front panel electrical trace rotator • Regulated power supply circuit for accuracy • TV video sync • High frequency rejection filter in the triggering circuit

$1799 Q 0160S 100MHz | $1499 Q 0157S 60MHz

Dual Tracking Lab Power Supply

NEW

Superb quality power supply for anyone who regularly test, fix or do R&D on complex equipment with split voltage rails. Supplies can operate independently, in series, or parallel. **Features:** • Separate controls for voltage and current limiting • High precision • Overload & short circuit protected • Excellent regulation • Floating outputs

$549 M 9220

3 POWER SUPPLIES IN ONE! 2 x 0-30V 5A PLUS: Auxiliary 1.5-6V 5A output!

Variable temperature soldering iron

This great adjustable soldering iron is easy to use and flexible enough to tackle small or big jobs. ***PICK ONE UP FOR THE TOOLBOX!***

HEATS UP TO A WHOPPING 450°C!

$46.95 T 2485

FANTASTIC BONUS: Pick up a T 2485 and get a **FREE** roll of solder (T 1100) **PLUS** a heavy duty soldering stand (T 1310)! **Valued at $20.85!**

2 IN 1 Soldering Station & Fume Extractor

NEW

$159 T 2444

Aren't you sick of soldering in a smoke filled workshop? Tired of coughing on fumes when your working on fiddly boards? This soldering station whisks away fumes with its powerful 120mm fan complete with replaceable filter. All metal construction ensures it will **last for YEARS** to come! • 60W • 1.6mm tip • Iron stand & sponge • Adjustable 250-430°C range.

SAVE BIG $$$ ON BUYING SEPARATE UNITS!

Prevent Battery Failure!

NEW

This solar charger maintains lead acid batteries in top condition, even over extended periods! Simply plugs into your cigarette lighter or connects directly. Use one on the car when you go away, or on the boat during off-season.

$29.95 M 0700

PREVENT PREMATURE BATTERY FAILURE! Great for cars, boats, yachts and caravans!

The Go-Anywhere Soldering Gun

2 IN 1 185W GAS IRON / BLOW TORCH.

Use it anywhere, no need for messy extension leads!

The ultimate tool for anyone in the trade or enthusiasts. It not only solders (550°C max), it can be used as a blow torch up to 1300°C for brazing and heat shrinking. Powered by unique refillable butane cartridges. Self standing design. Use it for up to 1.5 hours per cartridge (mid setting).

Supplied with 2 refillable cartridges! Keeps powering on for hours NON STOP!

$125 RRP $145 T 2650

Underwater video down to 30m!

It can even see in the dark! Great for outdoor use, or even as an aquarium cam! **B&W.**

Set up your own aquarium camera! Brilliant performer, even outdoors or water prone areas.

$150 RRP $189 S 9080

Measure temperature without touching

Lightweight and easy to use, this "non contact" infra red thermometer provides accurate temp measurement of any object. Great for taking readings in hard to get to, or dangerous places, or when equipment is operating.

$159 Q 1290

Floods from -30 to 550°C! Great for engineers, consultants, even auto mechanics!

NEW

Cheap insurance for your expensive appliances

NEW

Protect your equipment from damaging surges and spikes. *Not available at dealers*

SUPER LOW PRICE!
Great for protecting modems, TV, HiFi etc

	1 Way+Phone	6 Way	6 Way+Phone
	P 8131	P 8141	P 8151
Each	$10	$15	$20
Normally	$19.50	$27.50	$30

Mobile TV Antenna

NEW

$75 L 2000

A rugged weatherproof omnidirectional antenna for mobile installs. Supplied with mounting hardware, cabling and amplifier.

Great for the caravan, boat or camper trailer!

Premium terminal blocks!

10 for $10 RRP $1.50ea P 2130

Great for car wiring, audio cabling, hook up wire and much more! Keep a bunch in the toolbox, you'll never know when they'll come in handy!

Magnetic Connectors

NEW

Mag Connectors	5 pack
P 9190 18mm	$9.00
P 9191 60x4.5mm	$10.50
P 9192 70x4.7mm	$14.00

Small yet powerful conductive magnets for testing, prototyping, sensor triggers etc. Sold in matching pairs.

Multifunction Automotive DMM

NEW

Great for mechanical workshop classes! Serves not only as a standard multimeter, but also performs RPM, dwell angle, duty cycle, temperature and other automotive related functions. Supplied with inductive pick up.

$129 Q 1162

DIAGNOSE CAR PROBLEMS YOURSELF! Your could easily save a fortune on future ups & repairs!

Multi function mini-tester!

NEW

Feature packed, this screwdriver style tester performs a multitude of electrical test functions! It's able to check continuity, DC volts presence, microwave oven leakage and locate 240V AC mains wiring. With inbuilt LED and buzzer to indicate test status. Batteries included.

$9.95 Q 3000

The quick diagnostic tool! Even has features some $100 multimeters don't have!

BARGAIN BREADBOARDS!

An absolutely ***ESSENTIAL*** piece of gear for students, enthusiasts & developers. Allows circuits to be easily changed and re-tested.

Breadboards	Normally	NOW
P 1000 200 Way	$5.20	$4**
P 1005 640 Way	$11.05	$9**
P 1009 840 Way	$14.95	$12**
P 1012 1660 Way	$38.35	$29**
P 1015 2420 Way	$57.75	$39**

SAVE UP TO 33%!

BIG BASS Drivers!

Remarkable sounding high performance speakers. All feature a long lasting rubber surround. All 8Ω. Consult catalogue or website for full specifications.

HUGE BASS for a fraction of the cost of brand name speakers

PECC Speakers	Normally	1up	2up
C 3026 5" 60W	$89	$85**	$50**
C 3028 10" 80W	$89	$83**	$74**
C 3030 12" 100W	$109	$99**	$89**
C 3033 15" 100W	$149	$135**	$125**

Wattage ratings in RMS

Modular RJ45 Plugs

Make your own leads! SUPER LOW PRICE. *100 minimum

45¢ RRP $0.95 P 1418A

Spending heaps on regular batteries?

STOP NOW! THIS MAINS CHARGER WILL SAVE YOU BIG $$$! Pays for itself in no time! Suits AA NiCad or NiMH. Approx 7 hour charge time.

$18.75 A 0285

BONUS BUY: Buy the A 0285 and you can get 4 x AA 2300mAH (S 4746C) rechargeables (valued at $22) for just $10 more!

Wirepack for breadboards

NEW

Contains a huge assortment of solid single core insulated wire for use in breadboards, from 125mm lengths to simple "U" links. Supplied in a handy carry case! 350 pcs.

$15 P 1018

Insulation Tester

NEW

CHECK INSULATION BREAKDOWN IN JUST SECONDS!

An essential tool for testing electrical circuit "leakage" paths and insulation breakdown. Perfect for electricians or anyone who works on transformers or mains equipment. 200MΩ, 2000MΩ, 100-1000V.

$158 Q 1242

Data cable at wholesale prices!

	Cat 5e W 2780	Cat 6 W 2764
RRP	$1.05/M	$1.9/M
Per/M	**0.80¢/M**	**$1.30/M**

even better, buy a box...

305M box	$180	$298
that's only	33¢/M	66¢/M

Buy a box and save hundreds of dollars!

From only 33¢/M!

BARGAIN MODULAR CRIMPER

Suits 4-8 way modular connectors. With inbuilt stripper & cutter. *Make your own leads & save!*

$27 Was $55.95 T 1565

Keyring Stud Finder

NEW

Move it along your wall and it will seek out solid beams. Takes the guess work out of drilling holes in your walls!

Makes picture hanging a breeze!

$8.95 T 4500

Sensational price! These can sell for up to $600 elsewhere!

■ EXPRESS ORDER HOTLINE
1-300 797 007

■ FAX
1-300 789 777

■ EXPRESS
Overnight Delivery!*

■ NO RISK - MONEY BACK
14 day guarantee†

Stay charged up in the car!

12V battery charger plugs directly into your cars cigarette lighter. Great for charging batteries on the move. ie. digital cameras

Features: • Suits AA & AAA NICAD or NIMH • Discharge function • Memory refresh function

Note: Batteries sold separately. Piggback to suit M 9272, $14.50

BONUS BUY: Buy the A 0286 and you can get 4 x AA 2300mAH (S 4746C) rechargeables for just $10! Valued at $19.

$29.95
A 0286

Control access to your home or work

The perfect door strike for the RFID security kit! Operates from 12V AC or DC making it suitable for just about any

$40
RRP $47.20
S 5385

RFID SECURITY MODULE

SECURE YOUR HOME, WORKSHOP OR BUSINESS!

(SC June '04) Want to restrict entry to areas of your premises? This module interfaces easily to an alarm or doorstrike to provide a simple way to secure areas to just yourself or a specific group. Operates simply by waving an encoded tag in front of the receiver. Supplied with one keyfob, extras $9.95 ea (Cat No. K 9302).

$89.95
K 9300

Wireless Doorbell BARGAIN!

• Takes just 3 minutes to install! Totally wireless!
• Portable chime unit means you can even be in the backyard and hear the front door.

$14.95
A 0350

YOU WILL NOT FIND CHEAPER! These sell for around $30 elsewhere!

Datalogging Digital Multimeter with optically isolated RS232

The Brymen® BM202 digital multimeter has features usually found in meters 2 or 3 times the price! Datalogging feature is great for monitoring charge rates, temperature variations etc. *Features:* Auto ranging • FF mains detect • Data hold • AC/DC voltage • AC/DC current • Resistance • Diode check & buzzer • Frequency

FREE! Q 1082 RS232 Optical PC Interface & software to suit, valued at $24.95!

$149
Q 10805

Luxeon® Star Power Supply Kit

(SC Jan '04) This high efficiency switchmode power supply is designed to power a 1W Luxeon LED from two D cell batteries (for up to 20 hours). With brightness control. Great for low voltage lighting in a caravan or boat!

$42.50
K 1000

Buy the K 1000 kit and your choice of 1W Luxeon Star (Z 0690 or Z 0691) for **$50! SAVE $9.45!** (K 10005)

Luxeon® Stars

High power LEDs fantastic for use in low voltage lighting. They put out an incredible amount of light! Full specs available from: **www.luxeon.com**

$16.95
1 WATT

Z 0690: 1W White LXHL-MW1 C

$19.75
3 WATT

Z 0691: 1W Warm White LXHL-MWG C
Z 0695: 3W White LXHL-LW3 C

HIGH OUTPUT INVERTERS
Prices SLASHED by up to 33%

Mains power from a 12V battery ANYWHERE! ANYTIME!

POWERHOUSE INVERTERS are a fantastic choice for anywhere a remote power solution is required. For instance they can provide mains power to your appliances while camping or power up your tools when there's a job to be done, and not a mains socket in sight! Powerhouse is the choice of hundreds of farmers, 4WD enthusiasts, campers, mobile service technicians and tradesman all over Australia! All POWERHOUSE INVERTERS feature protection from incorrect polarity, over loading, over temperature and short circuits, making them incredibly easy to operate.

M 8142 & 8153: Perfectly suited for handing the startup surge of fridges, freezers, pumps, grinders and microwaves. These units will even power difficult loads like fluorescent lighting!

M 8022 & M 8042: Pure sine wave inverters for powering sensitive appliances such as computer equipment, microwave ovens, clock radios, sensitive medical equipment.

Inverters	Normally	NOW
M 8022 12V 450W Pure Sine	$449	**$349**
M 8042 12V 900W Pure Sine	$999	**$780**
M 8142 12V 1300W Mod. Sine	$699	**$540**
M 8153 24V 1800W Mod. Sine	$1199	**$799**

True RMS AC/DC Digital Clamp Meter

Quickly and easily measures the AC or DC current flowing through an individual inductor, up to a MASSIVE 600A! Rugged and well built to survive the rigours of use in the field. It also features, • AC/DC volts • Resistance • Temperature • Capacitance • True RMS AC measurement • One touch zero function • Peak hold • High quality test leads • Carry case

$169
Q 0966

GREAT PRICE! AMAZING FEATURES!
Essential test equipment for technicians, instrument fitters & electrical tradespeople!

My First FM Radio Kit... Teach your kids electronics!

$24.95
K 1112

Modern version of the "old" crystal set. *NO SOLDERING OR SPECIAL TOOLS REQUIRED!* So easy to build, even an 8 year old can do it! Runs off a 9V battery so its safe for anyone to build. Informative and easy to read manual provided.

SPEAKER Level Meter Kit

$29.95
K 2552

(SC April '04) With an inbuilt microphone and level meter this kit lets you adjust your home theatre or car audio system with high precision, ensuring each speaker is at the correct level for your whole system. Totally portable & easy to use!

Feature packed 10 Input Mixer!

This mixer can accept up to 6 line inputs and 2 microphones, mixing the audio output as you require! Each inputs gain control can be adjusted to keep your levels correct while the EQ ensures your sound quality is up to scratch. A crossfader lets you fade from one source to another seamlessly. Other great features include: • Cue selector

• Talk over switch • Phono inputs • Headphone monitor.

FANTASTIC FOR CLUBS, SCHOOLS, THEATRE GROUPS, DJ's OR EVEN AT HOME IN YOUR AV SYSTEM!

$270
A 2552S

FREE! A 2500 BNC Gooseneck Light to suit your new A 2552 mixer. Valued at $24.95!

Check data cable in just seconds!

Capable of checking all 8 conductors on modular cabling. Perfect for testing patch leads or system cabling.

Features:

• Automatic operation • LED indicators for all connections, including Ground • Suits 10Base-T, 10Base-2, RJ45, 258A, TIA 568A/568B and Token Ring • Includes carry case

$49.95
Q 3005

The ROBO-BUGGY Kit

Teach your kids electronics!

$39.95
K 1103

Robo-buggy features infra-red sensors & microprocessor intelligence allowing it to navigate around objects! An easy to build intro to mechatronics for kids!

Requires 4 x AA's. $ 4995 $2.85

Heaps of fun to build & play with!

ALTRONICS

Phone 1-300 797 007, Fax 1-300 789 777
MAIL ORDERS C/- P.O. Box 8350 Perth Business Centre, W.A. 6849
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Review: BeeProg Universal Programmer

By PETER SMITH

In the market for a professional all-in-one programmer? The new BeeProg Universal Programmer from Elnec is worth a look.

ESTABLISHED IN SLOVAKIA in 1991, Elnec specialises in professional development tools, including emulators, simulators, logic analysers and of course, device programmers. The BeeProg Universal Programmer is a recent addition to their product line-up, differentiated from previous models primarily by its USB support. It also supports higher programming speeds.

The BeeProg operates in conjunction with a PC and Windows-based control software. It can be connected via either the USB or a free ECP/EPP parallel port. As of writing, it can program 12,080 unique devices, including EPROM, EEPROM, PROM, FLASH memory, NVRAM, serial EEPROM, PLDs and microcontrollers.

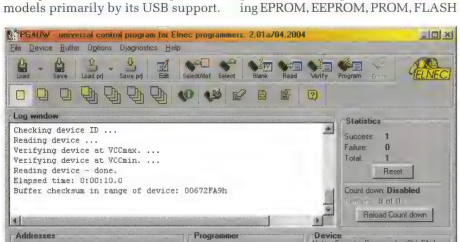

Fig.1: BeeProg's control software is easy to drive. Common functions are grouped along the main toolbar for one-click access, with all the important details displayed "up front".

Updates

Elnec updates their control software on about a monthly basis, adding support for new devices before or soon after they're released. You can download the updates free from their web site or opt for a paid subscription service to receive them monthly or quarterly via the post. Alternatively, you can register on-line to receive a free yearly update.

In the unlikely event that you need to program a device not supported by BeeProg, Elnec will add it to the list, resources permitting. This is their "Algorithms on Request" service and it's provided free of charge.

Programming overview

True "pin driver" technology means that all DIP devices can be programmed in the 48-way ZIF socket without the need for additional adapters. Elnec also offers a range of adapters for other package styles, including PLCC, SOIC, PSOP, TQFP and TSOP.

According to Elnec, only manufacturer-specified programming algorithms are used to ensure long-term reliability and maximum yield. Programming voltage (VPP) slew rate con-

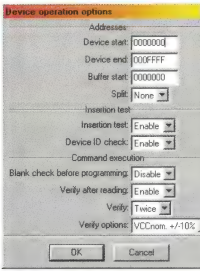

Fig.2: device operations are user-configurable via the Options menu. For microcontroller programming, you can also gain access to the fuse bits and ID locations from this menu.

trol and minimum/maximum supply voltage (Vcc) margin testing are all part of the package. In addition, reversed or "mis-socketed" parts are automatically detected at the start of each operation, with programmable current limiting included to protect the programmer as well as the device in the socket.

A useful inclusion is the ability to program Atmel, Microchip and EM Microelectronic microcontrollers in-circuit. Connection to the target system is made via a 10-way DIL header on the side of the case and a short length of ribbon cable. The programmer can supply target system power (selectable from 2-6V), as well as perform Vcc margin testing (assuming an appropriate on-board ISP interface).

In addition to device programming, the unit can also perform TTL/CMOS logic and static RAM testing. Test vectors are loaded from easy-to-interpret ASCII-formatted files, which also means you can generate your own vectors for PLD testing, etc.

The box

The unit is supplied in a bullet-proof steel case measuring 160 x 190 x 42 mm. A single button labelled "Yes!" next to the 48-way ZIF socket is a handy addition that speeds up multiple device programming and/or verification.

Once the software has been set up to program or verify the first device, subsequent devices can be inserted in turn, followed by a press of the button to repeat the operation.

A row of LEDs indicate system status, so you can immediately see when the operation completes and whether it passed or failed without referring to the on-screen display.

Control software

As mentioned above, the BeeProg programmer is controlled over a USB or parallel port link from your PC. The necessary software runs under Windows 95, 98, Me, NT, 2000 & XP.

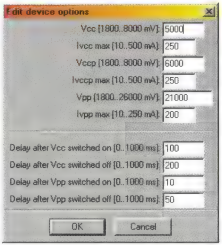

Fig.3: selecting a "generic" type EPROM rather than a specific manufacturer's type gives access to programming voltages, currents and several timing parameters.

All operations are performed from the main window, with often-used functions such as device read, blank check, program, verify and erase selectable via toolbar buttons and hot keys. Drop-down menus provide access to other less frequently used functions.

Device type can be selected from the huge list of supported devices according to class or manufacturer, or by simply typing in all or part of the type number. For EPROM and FLASH devices, you can also use the ID byte read function for automatic type detection.

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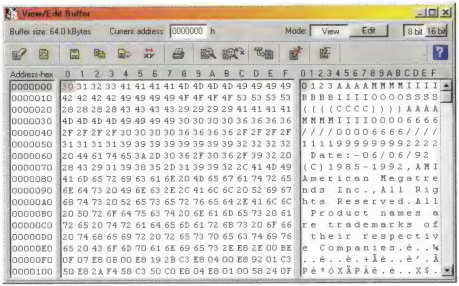

Fig.4: you can edit and massage the buffer contents in a variety of ways. If the function you want isn't included (unlikely), Elnec are eager to please and welcome suggestions for future versions of the software.

Virtually all aspects of the programming cycle can be customised to suit your particular needs. For example, you can choose to perform verifications at ±5% or ±10% of Vcc, or both. You can also decide whether an insertion test and device ID check are performed at the start of each cycle.

All known file formats are supported, with automatic format recognition on file open. Once loaded, a host of operations can be performed on the buffer contents; we don't have space to describe them all here. Essentially, the contents can be edited, moved, copied, swapped, erased and split odd/even as well as four ways.

In addition, you can checksum a defined area of the buffer in a variety of ways, including MD5 hashsum. The results can be automatically inserted at a defined buffer location or saved to a "project" file along with other settings.

Also of note is the auto-increment function, which enables you to assign individual serial numbers to each programmed device. Programmed numbers can be saved and retrieved from a file for consistency and documentation purposes.

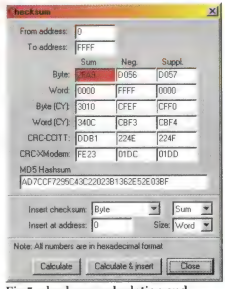

Fig.5: checksum calculation and insertion couldn't be simpler.

The BeeProg comes with a 3-year parts & labour warranty, with a limited (25,000 cycle) warranty on the ZIF socket. The software includes a diagnostics menu that allows quick and easy self-testing to be performed with the aid of the supplied diagnostic "pod".

Elnec programmers are available in Australia from Grantronics. They are on the web at **www.grantronics.com.au** or phone (02) 9896 7150. Technical information is also available from the Elnec web site at **www.elnec.com**.

As of writing, the BeeProg universal programmer was priced at $1300 plus GST, subject to exchange rate variations. SC

Summary

The only minor point noted during our short review is that a number of supported devices can't be programmed over a USB link; they specifically require a parallel port connection. However, USB support is improving with each software update.

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Vintage Radio

By RODNEY CHAMPNESS, VK3UG

Bill Clarke with the author's fully-restored WS122 transceiver. Bill designed the modulator and much of the switching mechanism for the WS122, while two other engineers – Lindsay Cobb and Geoff Frew – designed the receiver and transmitter sections and the vibrator power supply

Meet a designer of the legendary WS122 army transceiver

Ever wondered about the people who designed our vintage radio equipment? Most of the names have now been lost but not all. Recently, we were given the opportunity to talk to one of the engineers who helped design the Australian Army's classic WS122 transceiver.

VINTAGE RADIO has several different aspects that are of interest to its devotees. In the main, it involves collecting and restoring old radio receivers but other areas of interest include the collection of historical information, advertising material, and instruction manuals and data books from the era.

However, there is one area in which very little interest has historically been shown – the designers of the equipment and the circuit designs they produced.

The original designers of our vintage radio equipment were something of a mixed bunch. Many were highly qualified electrical and radio engineers but they also included many self-taught people with no formal education in the electrical or radio fields. But how many designers have you seen mentioned in vintage radio articles or in the historical literature? The answer is "very few, if any".

Of course, very few of the designers from the valve era are still alive. They are a mostly forgotten group of people but they engineered the many unique Australian designs that we can rightly be proud of today.

In the October 2002 issue, I described the WS122 portable high-frequency (HF) radio transceiver built by Radio Corporation for the Australian Army during WW2. About a week after the publication of the article, I received a phone call from Lewis "Bill" Clarke. I'd never spoken with Bill before but he introduced himself and told me that he was one of the designers of this set.

It was too good an opportunity to miss. I asked Bill if I could interview him when I next came down to Melbourne. He agreed and a few weeks later we sat down for a very interesting trip down memory lane.

Lewis (Bill) Clarke (VK3ZLN)

Bill turned out to be a sprightly, very "with it" octogenarian who was born in 1921. And his theoretical and

practical knowledge of electronics is quite extensive.

Bill spent most of his primary school years in Naracoorte, South Australia. His father was a bank manager and as a result they lived in one of the substantial residences provided for managers in those days.

According to Bill, the family obtained a battery-operated radio some time around 1930. As a result, a short water-pipe mast was installed on top of the second storey of the residence to support one end of the antenna, while another water-pipe mast was erected in the back yard to support the other end.

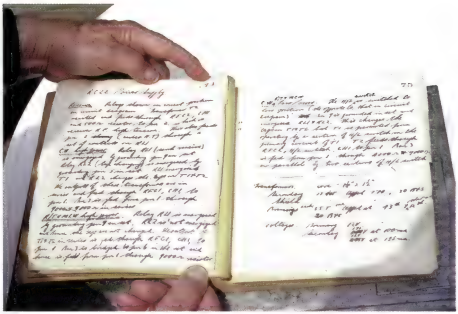
He estimates that the antenna would have been between 18 and 20 metres high, which meant that the radio quite easily received ABC stations 3LO and 3AR from Melbourne. The transmitting power of these two stations at the time was quoted as 5kW but that may have been the DC input power rather than the output power.

At the time, Bill enjoyed constructing many projects with his Meccano set. He ponders whether Britain's ability in the engineering field deteriorated at the same rate that Meccano sets disappeared from boys' lists of "toys".

At the end of 1932, the family moved to Ballarat – just after Bill had finished grade 6. And in one of the rooms of their new bank residence, there was a crystal set with a horn speaker attached. Yes, a loudspeaker crystal set and it did produce quite reasonable volume. Of course, such sets are rare but it was also quite rare to live right across the road from the local broadcasting station. In this case, it was 3BA which was located on the roof of a bank building across the street.

The family shifted again in 1934, this time to Melbourne, where Bill completed his secondary education at Scotch College. It turned out that a friend at the college had a crystal set and from here on Bill really became interested in radio, setting the scene for his life-time interest in the radio-electronics field.

When he had completed his studies at Scotch College, he entered Melbourne University to study Electrical Engineering, with particular emphasis on maths and physics subjects. This gave the degree a leaning towards the field of radio. His studies went well and during holidays, Bill took technical jobs with the railways in 1939-40 and with the tramways in 1941-42.



Bill Clarke still has his design notebook from his days with Radio Corporation and these pages show the notes he made on the transceiver's power supply.

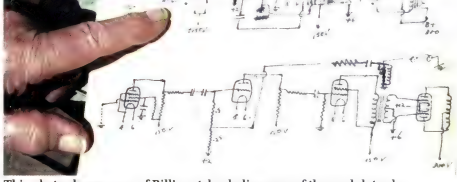
By now, the world was gripped by war and things were very grim in late 1941. As a soon-to-be graduate engineer, Bill could have obtained a commission in the submarine branch of the Navy, so he enlisted and continued with his course. But things didn't work out that way.

The British government had learnt from the first world war that there was no future in sending skilled and highly-qualified people off to the trenches to be killed. Australia quickly followed the British example and in early 1942 enacted manpower control. This meant that skills would be used where they would achieve the best results for the war effort. The final year of the course had to be crammed into half a year as the shortage of engineers was acute and so Bill qualified in June 1942.

Bill joins Radio Corporation

Bill commented that his long term interest in amateur radio may have saved his life, as he was drafted to work at Radio Corporation alongside another engineer (John Hill) who had done the same subjects (no – it wasn't the John Hill who previously wrote for "Vintage Radio"). John was also interested in amateur radio and ultimately obtained the callsign VK3DAD.

Bill found Morse code difficult to learn, as many very technically competent people do, but ultimately obtained



This photo shows some of Bill's notebook diagrams of the modulator he designed for the WS22 and WS122 transceivers.

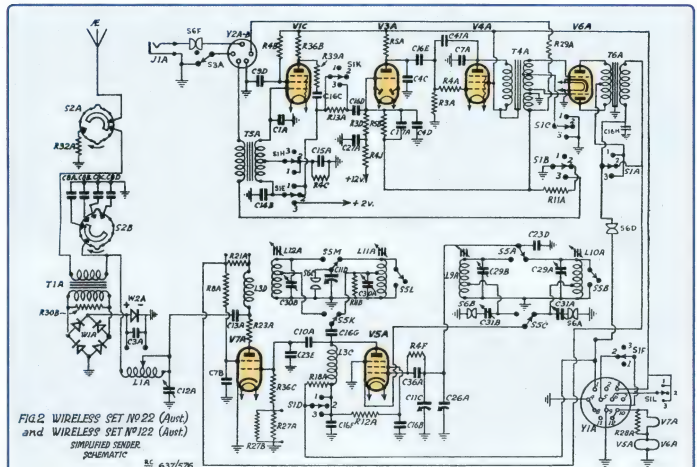


Fig.1: a simplified circuit of the WS122's transmitter. It had three modes of operation: voice (AM), Morse (CW) and modulated continuous wave (MCW).

the callsign VK3ZLN. Amateur radio operators were not allowed to operate their stations during the war so neither Bill nor John obtained licences at that stage.

By now, the Americans were bringing large quantities of radio communications equipment into the country and these required crystals to suit frequencies used in Australia. As a result, there was a large backlog of crystal orders and so Bill's first position in Radio Corporation was in the crystal laboratory. Here, he was responsible for the final grinding of the quartz crystals to the correct frequency.

According to Bill, the work load was so great that three shifts over 24 hours were initially required to catch up on the backlog. He was fortunate that his parent's home had shutters on the windows, so he could sleep during the day while working the night shift.

Once the crystal backlog had been eliminated, Bill was transferred to the design laboratory. But like many "new boys" in a job, he was initially given a variety of tasks to see what he was capable of. One of these tasks involved the development of a pre-heater for bakelite pellets, prior to moulding. As we know, bakelite was used extensively for radio cabinets at that time but not for military equipment. Apparently, Radio Corporation was still involved in domestic radio production to some extent, at that time.

He was also given the task of designing and building a 500-watt public address amplifier for the factory and this ended up using a couple of high-power transmitter valves to achieve the necessary output power. But perhaps one of the more interesting jobs at that stage involved fault-finding equipment that wasn't performing as it should.

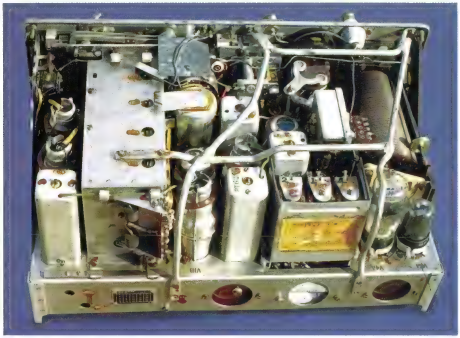
Often, equipment faults were due to the use of below specification valves. To solve this problem, Bill usually tried substituting good-quality valves of JAN (Joint Army Navy) specifications in the equipment (note: as many vintage radio restorers already know, some valves are marked to indicate that they meet JAN specifications).

For example, one particular VHF AM/FM communications receiver was found to be quite noisy and was giving quite poor performance. It was eventually found that the IF stages had insufficient gain and that the last IF stage would not saturate on FM signals. This problem was overcome by changing the screen and bias voltages in the IF stages to increase the gain.

Bill thinks that the receiver in question was an RT17 and it became quite a successful piece of equipment in its modified form. And once a piece of military equipment had successfully passed all tests, a handbook had to be written for it.

Designing the 22/122

Bill's next job involved designing the WS22 and WS122 army transceivers (the "WS" stood for "Wireless Set" and was commonly dropped from the type



This rear chassis view gives some idea of the complexity of the WS122 transceiver. Note the roller inductor tuning coil at the right of the photograph.

number). There were three engineers on the project: Lindsay Cobb designed the receiver, Geoff Frew designed the transmitter and the vibrator power supply, and Bill, the junior engineer, designed the modulator and much of the switching mechanism.

Geoff Frew had been an amateur operator (VK3PM) before the war and had the unusual nickname of "Afternoon Tea". Apparently, this came about because of the "3PM" in his callsign, 3pm being the usual time that people stopped work for a "cuppa" tea. His experience with transmitters proved to be invaluable in designing the RF section of the set.

In fact, Lindsay Cobb and Geoff Frew were arguably the best design engineers in Radio Corporation at that time, having been there for many years.

The design criteria for the WS22 and WS122 transceivers were set down by the military in general terms. The RF power output, frequency range, modes of operation, power source, receiver sensitivity and ability to load into certain types of antennas were some of the parameters that had to be met. But just how Radio Corporation met these design requirements was entirely up to them.

Prior to the development of the WS22 and WS122 sets, an earlier set named the "Yellow Band 22" had been developed which had used a grid-modulated transmitter. This set was an Australian adaptation of the British 22 set but Geoff disliked the grid modulating system and set Bill the task of designing a high level modulator.

As a result, Bill looked around for quite some time to find a valve (or valves) and a practical circuit configuration that would provide 10W of audio output from the modulator. At that time, class B amplifiers were not looked on particularly favourably as they tended to have high distortion. For example, the No.19 battery twin-triode class-B amplifier was used in a number of pre-war battery receivers. Unfortunately, it was unable to provide a low-distortion output, mainly because it was used without negative feedback.

Bill decided that the 53 would be a suitable valve type but its heater requirements of 2.5V at 2A ruled it out. The 6A6 could also be used but the relatively new 6N7 appeared to be even more suitable.

He rang Max Brodribb, a controller of valves in the Department of Supply, to find out the availability of 6N7s. He was in luck – they did have enough 6N7s for the job.

Having determined that the 6N7 would do the job, Bill then had the task of designing the modulation and driver transformers to suit it. Transformers are expensive and heavy devices but the design team believed that the end result of using them in a class B modulator far outweighed their deficiencies.

There were no computers in those days, which meant that slide rules, charts, technical manuals and many note books were needed to accomplish the design tasks. The accompanying photographs show just a few pages from Bill's note books. Some of the information has faded over time but the test notes and rough circuit diagrams can still be seen.

The 6N7 was normally used with

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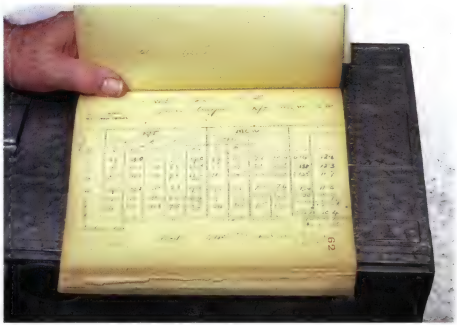

Also in Bill's notebook are the original test figures on the WS22 and WS122 prototypes.

zero bias but Bill decided to run it with a bias of -6V to minimise current drain – even though it may not then provide 10W output. The 6N7 required only voltage drive until the audio drive signal overcame the bias, after which it required power as grid current would then be drawn by the valve. This made the design of the driver transformer more difficult and made the load on the 1F5G driver valve (and receiver output valve) quite variable.

As a result, there would be significant audio distortion.

However, it was found that negative feedback from the headphone winding of transformer T4A to the grid of V3A (1H6G) – the second audio stage – overcame most of this distortion. Capacitor C41A, which was connected between the plate of V4A (1F5G) and its grid, also improved matters and so the combination of current and voltage feedback proved to be very successful.

Bill pleaded with the army to leave out the requirement to have an MCW transmit facility, as it made the switching extremely complex. In fact, the inclusion of MCW meant that six relays were required in the set. However, the military refused to change the requirement and no satisfactory reason was ever given to Bill for its inclusion.

I subsequently spoke with Tony Bell in South Australia on this subject and his thoughts were that MCW was included so that simpler AM-only receivers could be used with the 122 if need be.

Geoff Frew and Lindsay Cobb (both now deceased) relied extensively on their pre-war experience during the design phase of the WS122. As a result, many new designs copied the best features of older equipment that was about to be made obsolete. One example was the use of a dynamic microphone, as previously featured in the predecessors to the WS22 and WS122.

Tropical proofing

In the early days, there were many lessons to be learnt about building equipment for use in hot, humid locations such as New Guinea. It was not uncommon for equipment to come back for service with fungus growing in it and with open-circuit transformer windings and so on. A lot of this early equipment became useless in a very short time indeed.

However, the lessons were learnt quickly and before the 22/122 went into service, nylon covered wire and potted transformers were installed. In fact, these sets was almost hermetically sealed, as described in the October 2002 issue. All equipment for use in the tropics was then tested in an environmental cabinet at 100% humidity and 100°F.

The design and prototypes were accepted by the Australian Army on 14/3/1944. As far as can be determined, each 122 transceiver cost about 1000 pounds, with Bill being paid 6 pounds per week at that time.

And so the design of one of the icons of portable military radio transceivers was now complete. Bill's contribution can be readily appreciated and gives us an idea of the work that went into designing this and similar radio equipment.

Unfortunately, I haven't been able to provide any detailed information on just how Geoff Frew and Lindsay Cobb went about the design of their sections of the set. However, it's obvious that some very competent engineers were responsible for the WS22 and WS122 transceivers.

I asked Bill whether he would have liked to have serviced the 122. His answer was "No". For its time, there was a lot packed into a relatively small space, so servicing wasn't easy.

Life after Radio Corporation

Bill subsequently left Radio Corporation in June 1945 and joined the CSIR, which was the predecessor to the CSIRO. Although he wasn't involved in designing radio communications or entertainment equipment for CSIR, he was involved in the design of high-power radio frequency (RF) heating

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units to dry timber and to glue timber sections together. These units were, in reality, crude high-power (400-500 watts) radio transmitters.

He worked on many interesting projects while in the CSIRO, particularly high-precision test instruments. In many cases, it was necessary to develop new techniques to obtain the accuracy and precision needed.

So, overall, Bill has had an interesting and varied career in radio and electronics engineering. He even became involved with valve computers around 1969. He retired from the CSIRO in 1983, after a career of more than 40 years in radio and electronics. He is now living in contented retirement in a beachside suburb of Melbourne.

Geoff Frew & Lindsay Cobb

Bill felt that he was getting too much of the limelight in this article (the draft was sent to him for approval) and believed that as much information about the other two designers of the WS122 should be included. As a result, Bill put together some notes on these two very talented engineers.

In 1943, Radio Corporation had an RF design department of about 15 staff. There were many other sections such as a machine shop, drawing office, transformer manufacturing section, etc.

In the RF design section (Research Section), the main receiver design work was done by Lindsay Cobb. Lindsay had been with Radio Corporation for many years and was involved in the design of radio receivers for the domestic and other markets. Many fine designs can be attributed to him and he stayed with the company until his untimely death around 1960.

During Bill's time at Radio Corporation (1943-45), most of the transmitter design work was done by Geoff Frew. Geoff had come on strength with Radio Corporation during the war. According to Bill, Geoff's experience before joining Radio Corporation included the design of car radios and vibrator power supplies. His qualifications were in civil engineering but he switched to radio design, in which he excelled.

Geoff Frew left Radio Corporation after VJ day (the day of the Japanese surrender) to concentrate on his own small private company. He initially made moisture meters for the timber trade under the trade name of "Techtron" but soon expanded into making attenuators, audio signal generators (20Hz - 200kHz) and low RF level vacuum-tube voltmeters.

His crowning glory came when he made the prototype and production models of the Atomic Absorption Spectrophotometer in about 1964 for the CSIRO. He continued to make these for world-wide supply until 1967, when his business was bought by Varian Associates. Geoff was the complete radio and electronics designer and he died around 1975.

Photo Gallery: 1939 HMV 449

One of a series of mantel receivers produced by The Gramophone Company (Sydney) in 1939, the HMV 449 was a 4-valve superheterodyne unit fitted with a 6-inch (150mm) electrodynamic loudspeaker. The valve line-up was as follows: 6A8-G frequency changer, 6G8G IF amplifier/detector/AVC rectifier, EL3NG audio output and 5Y3-G rectifier. Photo: Historical Radio Society of Australia, Inc.

Others who made it happen

Although Lindsay, Geoff and Bill designed the transceiver circuit, there was also a team of people who made the WS22/122 transceiver a reality when it came to manufacturing the unit. These people did all the "nuts and bolts" work on designing the chassis layout, the wiring looms and the positions of the front panel controls – and this isn't a simple task in a complex piece of equipment like the 22/122.

It is important that a piece of equipment must work properly under all conditions and component layout can be quite critical. Tropic proofing and semi-hermetically sealing the complete transceiver and power supply was also a very important activity that was taken on by this team.

In addition, they devised carrying cases, wrote an instruction manual and did lots of other "little" jobs to make the design a success. Their names have all probably been lost in history but without them this highly successful transceiver would never have been more than a prototype.

Summary

The brilliant trio of Cobb, Frew and Clarke designed a cutting edge military transceiver that was well ahead of its time in a number of design areas. In fact, it was still considered quite suitable for use in many communications services for many years after the war finished. It only finally became obsolete when single sideband (SSB) transmissions became mandatory in the late 1970s.

Lindsay Cobb and Geoff Frew were Bill's mentors, providing him with invaluable assistance for his future career. Of course, it would have been tremendous to have been able to talk with both Lindsay and Geoff as well but I'm about 40 years too late.

And so, many thanks to Bill Clarke for sharing some of the history of radio design in the 1940s. It really was intriguing to learn how the WS22/122 transceivers were designed. SC

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Blown Mosfets in battery controller

I am writing in regards to a 12V Battery Controller kit which was described in the January & February 1996 issues of "Electronics Australia". After assembly, I followed the instructions in the test procedure. Applying 12V was fine; applying 13.5V was fine and the appropriate LEDs lit up.

However, when grounding the AUX terminal, Mosfet Q1 burnt out. The leg going to the AUX terminal has blown off completely. I tested that there was no continuity between the terminals MAIN, AUX and ground, and the Mosfets and ground. There appears to be no flash marks from the mica washer to ground.

I would appreciate some information on what could have caused the problem and how I can go about fixing it. We are travelling around Australia and I need to get the kit going soon. (S. K., via email).

- It seems likely that during the test where you connect AUX to GND, you did not have AUX MON connected as well. In other words, AUX and AUX MON should have been both connected to GND. This would tell the monitoring part of the circuit that the AUX battery voltage was low and would throttle back the Mosfets and allow the test to be safely made.

If you did not have AUX MON connected to ground, you would probably blow both Mosfets. We would be surprised if they are both not blown.

Sound-activated switch for lamp control

I am doing a Year 12 major assessment task and I have decided to do a sound-activated lamp (clap and it turns on; clap again and it turns off). It needs to be 12V.

Have you ever produced a kit for this or would you know where I could get a circuit diagram? (T. B., Port Macquarie, NSW).

- While we have not produced a sound-activated switch as such, the Dog Silencer project featured in the April 2004 issue includes a circuit which could be adapted to your application.

6V DC-DC converter for vintage car

Could you please tell me if SILICON CHIP has done any projects on DC-to-DC up-converters (namely 6V to 12V)? I don't seem to be able to find anything available commercially.

I wish to run some 12V items in a vintage car that has a 6V system. (W. H., via email).

- The DC-to-DC Converter from the June 2003 issue of SILICON CHIP will do the job. It provides 2A output. To operate at 6V, we recommend replacing Mosfet Q1 with a logic FET. Jaycar sell these – Cat. ZT 2271.

More LEDs for USB lamp

I'm from Argentina and I really LOVE your web site. I want to build the "Itsy-Bitsy USB Lamp" from the March 2002 issue but I want to use six or eight LEDs instead of one.

Is this possible? Should I connect them in series or parallel? Should I change the resistor? (M. B., Buenos Aires, Argentina).

- Since the USB only supplies 5V, you cannot put the LEDs in series. You could have two or more in parallel but they would each need their own 47Ω limiting resistor.

SCRs in a big battery charger

I have a number of fairly big SCRs (200A) already bolted to heatsinks. Is it reasonable to use these as rectifier diodes in a charger for my 48V 650Ah lead-acid fork-lift battery? Presumably I could simply turn them hard-on by hard-wiring their gates.

Clearly, a 3-phase bridge would give much better ripple voltage. What benefit would accrue if I went that way? (Don't all real men have 3-phase in their garages?)

By the way, I presume with a battery charger that the current only flows while the instantaneous rectified voltage exceeds the battery voltage. Is that right? Would it not then give a pretty odd-looking current waveform?

Can you suggest an existing circuit for a trickle charger that could be tweaked (just a little) to do my job or do I need to go from first principles?

Also, with a single phase, centre-tapped transformer of say 1A rating, if I use just two diodes as a rectifier, what current can I get in terms of DC? It appears to me that it would be a little

Weak Video From A/V Transmitter

I built the Audio/Video Transmitter featured in the July 1999 issue. It transmits audio perfectly but video has "snow" on screen.

I checked component polarity, PC board placement, etc and all is OK. The soldering is very neat and good quality. I am transmitting around eight metres in a plasterboard and timber frame home. The antenna on the transmitter is a telescopic whip (990mm) and on the receiver is a telescopic "Rabbit Ears" (700mm).

Can you please help with this problem? Or can the circuit be improved to be more reliable and give better quality? (M. V., via email).

- One of the upc1688G amplifiers is probably not working or is reversed in its positioning on the PC board. Check the orientation and soldering of each device. Alternatively, one of the coupling capacitors between these amplifiers could be shorted or is the incorrect value.

more than a 1A (1.4A?), since while each half of the secondary can take 1A (if I'm lucky), it will only be driving the load every half cycle. But with I^2R copper heating, the heating will not allow me to use twice the current for each side of the transformer. Your thoughts? (D. W., via email).

- We would not hard-wire the gates to the anodes; instead, connect them via a 220Ω 0.5W resistor.

Assuming you had a 3-phase transformer, a 3-phase bridge would give lower ripple but otherwise there is no benefit.

In any rectifier, current only flows when the diodes are forward-biased and the voltage is greater than that at the load; eg, the battery. The resulting current is a series of short pulses at 100Hz, for a 50Hz single phase bridge rectifier.

We published a 12V trickle charger in October 1998 and this was modified for 24V operation in the February 1999 issue. In principle, the same circuit could be adapted to 48V operation.

In any rectifier circuit, the power output can be no more than the transformer can supply and since the rectifier current is in the form of high-current pulses, copper losses in the transformer and power losses in the rectifiers can be significant. If your transformer has a rating of say 30VA, you can't expect any more than about 28VA from the whole circuit without overloading the transformer.

Cordless connector for guitar

I am a guitar freak and need an easy solution to connect my guitar to an amplifier, as I find it difficult to perform with a long cord hanging around my guitar. Can you please suggest a circuit for a cordless solution? (A. G., Delhi, India).

- You could use an FM transmitter and FM receiver such as a standard FM tuner. Have a look at the FM Transmitter for Musicians in the November 1998 issue. This can be used to transmit guitar signals.

Optocoupler for PC-controlled switch

I am having trouble finding a part for the PC-Controlled Mains Switch (SILICON CHIP, September 2001). I can't find or track down an SFH601-3 optocoupler, as Dick Smith Electronics doesn't stock this part any more.

The article states "DO NOT SUBSTITUTE" and I have tried Farnell, RS and various other electronic suppliers with no success. Can you make a suggestion? (M. T., via email).

- The CNY17-3 optocoupler is also suitable. It is available from Farnell Electronics, Cat. 359-8380.

Which amplifier to build

I am in a quandary about which amplifier to build. I want something with quite high power and there are two amplifiers to choose from: the 500-watt monster described in August/September/October 1997 or the more recent Studio 350 in the January & February 2004 issues.

I do have problem trying to obtain a suitable 800VA transformer but apart from that, all the parts seem to be available. Can you throw some light on my problem? (R. B., Berala, NSW).

- As you have probably realised, the decision on which one to build is not clear cut. On the one hand, the 500-watter described in 1997 is a complete amplifier with power supply, fan-cooled heatsink, relay protection, thermal cutout, etc. It is basically intended to be a real work-horse, whether in PA, music or domestic use.

The Studio 350 has been presented only as a PC board module and you would need to do a lot to end up with a complete amplifier in a case, although you could use the fan control and relay protection from the 500-watter. And while there is nominally a large difference between the power outputs of

Logging Motorbike Fuel Mixtures

I recently purchased a Fuel Mixture Meter kit, although I haven't begun assembly yet. I would like to record the A/F ratio relative to RPM and throttle position and have also purchased a data logger kit which has both digital (16) & analog (8) inputs. I also have a strain gauge and amplifier to measure loads on a motorbike dyno I've designed and built in the back shed.

With the fuel mixture kit, I thought I would fit some DIP switches so I can choose to switch resistors R1, R2 and R3 on and off. This I can manage but what I would really like would be a digital output to the data logger of the air-fuel ratio and it is beyond my abilities to work out a method.

I assume I could pick up the raw digital signal at pin 1 of IC2a but this won't give me a very user-friendly figure to log. Can you recommend a way to export a processed digital output signal of the A/F ratio to my data logger? (B. G., via email).

- The Fuel Mixture Meter is not designed to connect to a data logger. This is because it does not produce an output in serial form, as it was designed just to drive a display.

At best, you can log the voltage from the oxygen sensor but make sure the loading on the sensor is 1MΩ or more. You can convert from the raw oxygen sensor voltage to an air-fuel ratio by comparing the voltage against a graph of the sensor's output curve.

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Multi-spark CDI for motorbikes

I would like to know more about Multi-Spark CDI Ignition systems as described in your "Electronic Projects for Cars, Volume 2". I have a 1999 Honda XR250R and would like to redo the ignition side so I can make my own fully-controlled CDI unit.

I would like to know if the "exciter coil" on a motorbike does the same job as the +300V line on your project. If this is true, then does that mean that I would only have to build the IC2 side of the project in order to get multi-spark?

Since my motorbike does not have a battery (and I intend keeping it that way), is it possible for the generator to charge a quite large capacitor and use this to power the MSD CDI unit?

Is there any benefit in connecting a medium-size (say 50-100µF) 275VAC capacitor across the +300V supply to reduce noise and increase power? It says that it's possible to include another 1µF 275VAC capacitor in parallel with C2, connected to the coil positive. Will this maybe give a small boost or something, even if just a single coil is used? (A. L., via email).

● The IC2 circuit can be powered from the 300V from the motor bike coil. This means the IC1 boost circuit would not be needed. You should not need to place a capacitor across the 300V supply.

A second 1µF capacitor in parallel with C2 will give more spark energy.

the two amplifiers, in decibel terms, it comes down to a difference of about 1dB which is hardly worth worrying about.

Where the Studio 350 amplifier is a clear winner is in terms of residual noise and distortion, although the margin would be less if the two were adjusted to have the same closed-loop gain. By way of explanation, the Studio 350 has a voltage gain of 23 (27dB) while the 500W amplifier has gain of 33 (30dB).

What would we do? For home listening, where you want the best possible distortion figures, we would choose the Studio 350 but there would be quite a lot of work to turn it into a complete stereo power amplifier. For a general workhorse, we would pick the 500-watter.

If you want an 800VA transformer, contact Harbuch Electronics. They advertise each month in SILICON CHIP – see page 87 in this issue.

Crossover wanted for subwoofer

I made a 50+50W amplifier several years ago which drives two Philips speaker enclosures, with tweeter, midrange and 12-inch woofers. A while ago, I decided I did not have quite enough bass and because the speakers are five metres apart (the room is a combined lounge/dining room 5.2 x 10m), there is a "hole in the middle", as I have heard it called.

About a year ago, I had a subwoofer box built to suit a 12-inch (300mm) Polycone Woofer (Cat. CW2130) which I bought from Jaycar. I also purchased a 4-inch (100mm) midrange speaker with a fully enclosed back and this will also go in the enclosure.

I have built a 50W amplifier from a kit and intend to use it to drive both woofer and midrange speakers. I don't need a huge bass output and I don't have "golden ears". I intend to drive this "centre amplifier" from the speaker output in each stereo amplifier, through isolating resistors of a few kilohms, of course.

My query is, how do I calculate the series choke for the woofer and the series capacitor for the midrange to give a reasonably balanced output from both speakers? (N. W., via email).

● There are a number of problems you need to address. First, you need to know the efficiencies of the two drivers. It is probable that you will need a series resistor to attenuate the level of the midrange to match the proposed woofer.

Second, simply placing an inductor in series with the woofer may not give a rapid enough rolloff below your chosen crossover frequency. Third, what is your proposed crossover frequency? It should normally be well below any cone resonance of the midrange.

Fourth, and related to the third question, a simple capacitor crossover may not be adequate for the midrange. You might need a second order filter (ie, a capacitor and inductor) and this needs to take into account any attenuating resistor. That said, it is not possible for us to give definitive answers to your questions. You may like to obtain a book on speaker design before you proceed further.

Ultrasonic cleaning fluids wanted

I have finally given up trying to find the necessary components and information to build an ultrasonic cleaner and have bought one. However, I am still in the dark as regards the correct cleaning fluids to use on various items such as silver-plate, brass, copper, glass and plastics. I would be grateful if you could tell me where I might get this information.

I have been unsuccessful on the internet and no information came with unit. (E. P., via email).

● For most cleaning, normal detergent in water (ie, for washing dishes) is fine. Don't use dishwasher detergent – it is too caustic. And don't use an ultrasonic cleaner to clean "paste" jewellery – there is a danger that the "paste" will dissolve.

There is quite a lot of information on the net. Just search for "ultrasonic cleaning fluids".

Query on speaker earth return

I have been a purchaser of EA/ETI/AEM/SC magazines and kits since the Playmaster 136 onwards and have built and repaired so many (both professionally and for friends) that I can not remember them all!

My query is regarding the SC480 amplifier module. The PC board layout as described is excellent but for the best damping factor why doesn't the speaker common return directly to the power supply reservoir capacitors instead of to the PC board (voltage drops, etc)? (D. B., via email).

● Connecting the speaker return to the main capacitor centre point would give a worse result since the feedback is taken from across the output and centre earth point on the board. In any case, the damping factor of the SC480 is more than 140. We doubt

whether any EA or ETI design could better this.

White noise a hazard for tweeters

The Loudspeaker Level Meter in the April 2004 issue is a great idea but I have a niggling worry about your suggestion for using inter-station noise as a source. Isn't it nearly white noise?

If it is, there's a possibility that if you turn it up too loud for too long, you could endanger your tweeters. I could be completely wrong about this – I really can't remember how much HF energy is in inter-station noise. (G. B., via email).

● Inter-station noise is white noise and the signal from a typical FM tuner is quite high. However, the level meter has quite enough gain to allow you to do the tests at modest levels. Even a few watts of white noise is very loud and we doubt whether many people would run their systems at such a level as to put their tweeters in danger. It's a good point though.

Infrared remote controls explained

Could you please answer a question for me? In a remote control for a CD player like a Pioneer DEH-P3500 or a TV remote control, which has the emitter diode? The unit or the remote? Which has the detector diode? The unit or remote? I would greatly appreciate an answer! (S. A., Hot Springs, USA).

● All infrared remote controls contain an infrared light emitting diode while the unit being controlled (CD player, etc) has the detector diode to pick up the bursts of infrared. However "learning" remotes also have a detector so that they can receive and learn the codes put out by other remote controls.

Question on valve converter transformer

I wound the converter transformer for the valve preamplifier by following the instructions in Fig.13 but I don't seem to be getting any output from it. I'm not sure that I did it correctly. In step 2, the finish of the secondary wire is shown hanging from the bottom right of the transformer but no explanation is made as to what to connect it to.

I took a guess and wound it into the second layer of the secondary. Is this correct? Also, where the wire connections are connected to the pins, I soldered these on but the solder doesn't seem to stick to the wire very well.

Lastly, I only seem to be getting 11.75V from the 12V output, regardless of whether I feed the input with 12V or 15V. Is this sufficient? If not, how can I make the adjustment? (J. A., via email).

● The end of the first 40T layer of the transformer secondary winding is shown "hanging loose" in step 2 because it's left that way while you cover that first layer with a layer of PVC tape. Then it's used to wind the second 40T layer of the secondary, as shown in step 3.

It sounds as if you have tried to solder the winding wire ends to the pins on the former without scraping off the insulating enamel first. It's necessary to scrape the enamel off the ends (for about 8mm or so), to provide bare copper for the solder to bond to.

It's OK for the nominal 12V DC rail to measure only 11.75V – this should still give normal operation.

Using a CRO to monitor the mains

I seem to recall you published a circuit to allow a CRO to safely monitor the 240VAC mains without doing in either the vertical amplifier or the human but I can't find a reference.

I wanted to analyse the waveform produced by a cheap portable generator and using a 9V AC plugpack for isolation seemed to mangle the sinewave into a triangular wave. Did it exist or am I dreaming? (D. H., via email).

● It did exist – the Differential Input Buffer for Oscilloscopes, published in April 1992.

Notes & Errata

Courtesy Light Delay for Cars, June 2004: the 1MΩ trimpot (VR1) has been omitted from the parts list.

Dog Silencer Mk2, April 2004: some readers have difficulty winding the transformer. The windings will only fit in two layers.

RFID Security Module, June 2004: the photograph of the completed module on page 38 shows the microcontroller (IC1) reversed in its socket. The overlay diagram (Fig.3) shows the correct orientation for IC1. SC

WARNING!

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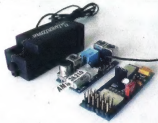

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